instruction manual

Beckman®

Berkeley Division

EVAL. INSTR. LAB.

INSTRUCTION MANUAL

DSEL
21

MODEL 7420 SERIES
PRESET COUNTER

7426

Serial 354

NOTE

If model number is followed by one or more letters, the instrument covered by this manual has been modified. See section on modifications.

Beckman/ Berkeley Division
Richmond 3, California

August 1959

WARRANTY

Instruments sold by Berkeley Division, Beckman Instruments, Inc., (hereafter called "the Company") are warranted only as stated below.

Subject to the exceptions and upon the conditions specified below, the Company agrees to correct, either by repair, or, at its election, by replacement, any defect of material or workmanship which develops within one year after delivery of the instrument to the original purchaser by the Company or by an authorized representative, provided that investigation and factory inspection by the Company discloses that such defect developed under normal and proper use.

The exceptions and conditions mentioned above are the following:

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(b) All instruments claimed defective must be returned to the Company, transportation charges prepaid, and will be returned to the customer with the transportation charges collect, unless the item is found to be defective in which case the Company will pay all transportation charges.

(c) The Company makes no warranty concerning components or accessories not manufactured by it, such as tubes, fuses, batteries, etc. However, in the event of the failure of any component or accessory not manufactured by the Company, the Company will give reasonable assistance to the purchaser in obtaining from the respective manufacturer whatever adjustment is reasonable in the light of the manufacturer's own warranty.

(d) Except as stated above, the Company makes no warranty, express or implied (either in fact or by operation of law), statutory or otherwise; and, except to the extent stated above, the Company shall have no liability under any warranty, express or implied (either in fact or by operation of law), statutory or otherwise.

(e) The Company expressly disclaims any liability to its customers, dealers, and to users of its products, and to any other person or persons for consequential damages of any kind and from any cause whatsoever arising out of or in any way connected with the manufacture, sale, repair, replacement of, or arising out of or in any way connected with the use of any of its products.

(f) Representations and warranties made by any person, including representatives of the Company, which are inconsistent or in conflict with the terms of this warranty (including but not limited to the limitation of the liability of the Company as set forth above) shall not be binding upon the Company unless reduced to writing and approved by an officer of the Company.

(g) This warranty shall be governed by the laws of the State of California.

Claims for damage in shipment should be filed promptly with the transportation company.

All correspondence concerning the instrument should specify the model and serial number. This information appears on the company name plate. Any inquiry concerning details of operation, possible modifications, etc., should be addressed to the Sales Department, Berkeley division of Beckman Instruments, Inc., Richmond 4, California.

REPAIR SERVICE

Experienced service personnel and special test equipment are available at the factory to perform any necessary repairs. Every effort will be made to expedite the repair of instruments returned for servicing. Repair work will be performed only upon receipt of a written purchase order or authorization. Instruments to be repaired should be addressed to SERVICE AND REPAIR DEPARTMENT with transportation charges prepaid. Repaired instruments will be returned to the purchaser with transportation charges collect.

Berkeley reserves the right to make changes in design at any time without incurring any obligation to modify equipment previously purchased to conform to subsequent design changes.

BERKELEY DIVISION
BECKMAN INSTRUMENTS, INC.

INSTRUCTION MANUAL REVISION

Models affected:

605	730A	7151
705A	903	7161
705AH	2020	7351
705AJ	2200	7361
705B	4904	7410
706A	5001	7420

Delete all references to tube type 7316

CONTENTS

	Page
1. INTRODUCTION	
1.1 General Description	1
1.2 Technical Characteristics	1
1.3 Applications	2
2. OPERATION	
2.1 Installing and Energizing the Instrument	4
2.2 Operating Controls and Indicators	4
2.3 Input Adjustments	6
2.4 Output Characteristics	9
2.5 Description of the Operating Modes	10
2.6 Operating Procedure	11
3. SERVICING	
3.1 Adjustments	13
MODIFICATIONS	
7400 Mod. A	
7000 Series	
DRAWINGS	
Preset Counter, Block Diagram, Dwg. No. 7420 D 16	
Indicator, Schematic Diagram, Dwg. No. 7420 D 2	
Switching and Control Circuits, Schematic Diagram, Dwg. No. 7420 D 1	
Input Circuit, Schematic Diagram, Dwg. No. 7000 C 300	
Output Circuit, Schematic Diagram, Dwg. No. 7400 C 3	
Power Supply, Schematic Diagram, Dwg. No. 7370 C 100	
APPENDICES	
Instruction Manual, Model 705AH DCU	
Instruction Manual, Model 705AHP DCU	

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1. INTRODUCTION

1.1 GENERAL DESCRIPTION

The 7420 series Preset Counter is an electronic counting instrument which produces an output in each of two channels whenever a corresponding preset count is reached. Each output is available both as an electrical signal and as a relay contact transfer, and can be of momentary or sustained duration. The preset count for each channel is selected with a corresponding set of front panel thumbswitches.

The instrument will count any series of physical events which can be translated into voltage changes of a given magnitude. It will count such events at any rate up to 10,000 per second and continually display the accumulated count in digital form on the front panel.

Any of five operating modes can be chosen with a front panel selector switch. The "Alternate" and "Dual" modes both provide dual channel operation. In the "Alternate" mode, recycling occurs alternately at the A channel and B channel preset counts; in the "Dual" mode, recycling takes place only at the higher (B channel) preset count (with simultaneous outputs in A and B channels at the B count). In "A" and "B" modes, the instrument provides single channel operation, with output and recycling occurring only at the preset count of the channel selected. The "Alarm" mode provides non-recycling operation in which the instrument produces an output at each of its two preset counts and continues to count.

The 7420 series includes four basic models (7423, 7424, 7425, and 7426) which differ only in total count capacity. The last digit in the model number indicates how many digits the instrument displays and hence its count capacity.

1.2 TECHNICAL CHARACTERISTICS

Input Sensitivity

100 millivolts rms (0.3 volts peak-to-peak)

Input Impedance

10 megohms in parallel with 40 $\mu\mu$f

Paired Pulse Resolution

70 microseconds

Maximum Counting Rate

10,000 per second

Count Capacity

Model 7423: 999
Model 7424: 9,999
Model 7425: 99,999
Model 7426: 999,999

Output Available at Preset Count Coincidence (A or B channel)

Electrical

Amplitude: 50 volt step (-20/+30)
Duration: 30 microseconds, 50 milliseconds, or sustained
Impedance: 250 ohms
Minimum external load resistance: 3500 ohms

Relay Operation

Momentary (50 ms) or sustained
(Dual form C contacts: 5 a., 117 v. AC, non-inductive)

Power Required

195 watts at 117 v. AC (±10%), 60 cps

Size

With cabinet: 20 in. wide, 10 5/8 in. high, 17 3/8 in. deep
Without cabinet: 19 in. wide, 8 3/4 in. high, 17 3/8 in. deep

Weight

45 pounds (with cabinet)

1.3 APPLICATIONS

The 7420 series Preset Counter can be used to monitor and control a wide variety of continuous or discontinuous processes. With appropriate input transducers such as photocells, magnetic pickups, and tachometers, the instrument can be used to count the passage of discrete items, the

revolutions of a rotating member, or the passage of linear units of a given material. The unit will accurately count such "events" recurring at relatively high repetition rates, and provide outputs suitable for control operations at one or two predetermined counts. Thus, the 7420 series instrument is useful for such industrial processes as sorting, packaging, batching, coil winding, and cutting to length.

The 7420 series Preset Counter can also be used as a two channel, digital frequency divider, with each channel providing output pulses at any selected submultiple of the input frequency. In addition, this instrument will provide output pulses whose duration and spacing can be accurately predetermined over a wide range.

2. OPERATION

2.1 INSTALLING AND ENERGIZING THE INSTRUMENT

The instrument is ready for use as soon as it is unpacked from its shipping container and inspected for damage in transit. Although there are no special installation requirements, the instrument must, for proper cooling, be operated inside its cabinet. The unit, can however, be removed from the cabinet and mounted in a standard 19 inch rack if a dust cover (available on order) is first installed over the top of the chassis. For rack mounting details, see MODIFICATION R[illegible] in the section on modifications.

To energize the instrument, connect the power cord to a 117 volt, 60 cps source, and turn the POWER switch on. After a warmup of about 2 minutes, the instrument will be ready for operation.

Figure 1 shows the relative locations of the output connectors on the rear panel of the instrument. For a description of the output signals available, see section 2.4 "Output Characteristics".

2.2 OPERATING CONTROLS AND INDICATORS

The following controls and indicators are located on the front panel of the instrument unless otherwise specified.

POWER switch

Energizes or deenergizes the entire instrument.

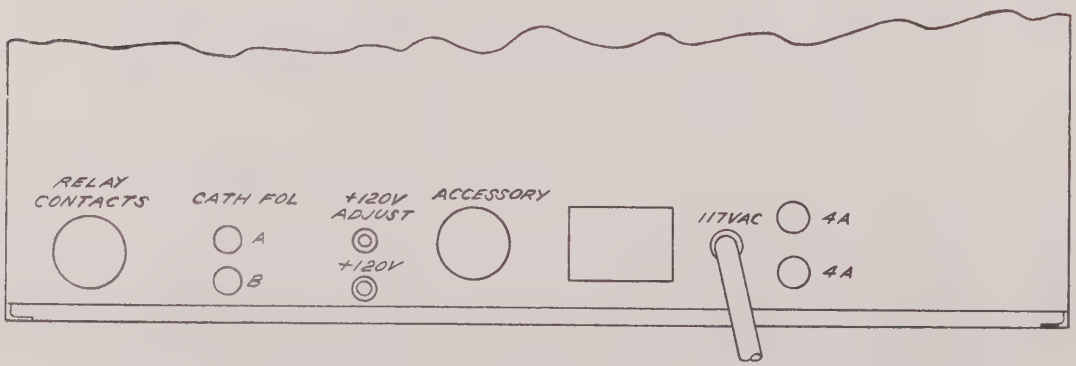


FIG. 1. Relative locations of connectors on the rear panel of the instrument.

FUNCTION switch

Selects the operating mode of the instrument.

ATTEN(uation) control

Attenuates the signal voltage at the input jack by the amount indicated. When turned to the AC side, only the AC component of the input signal reaches the input trigger channel.

TRIGGER control

Determines the instantaneous voltage at which the attenuated signal triggers the input channel.

Preset Count switches (A or B)

Select the count at which the corresponding channel will produce an output signal.

COUNT switch

Causes the instrument to start or stop counting.

Count indicators

Display registered count by illuminated decimal digits.

RESET button

Resets the count indicators to zero and deenergizes both output relays (if relays are energized).

RELAY TEST button (A or B)

Energizes the corresponding output relay while pressed (if relay is deenergized).

RELAY indicator lamp (A or B)

Indicates state of corresponding output relay; goes on whenever relay is energized.

Output selector switches (located on top of chassis)

Select the duration of the output signal from the corresponding channel (see section 2.4, "Output Characteristics").

2.3 INPUT ADJUSTMENTS

2.3.1 Adjustments for a Sine Wave Input Signal. Whenever the input signal is a sine wave between 10 cps and 10 kc, or any periodic signal whose slope changes sign only once between successive maximum values, the ATTEN(uation) and TRIGGER controls may be set as follows:

1) Couple the signal to the input jack. Input sensitivity is 100 mv rms (0.3 volts peak-to-peak). Input impedance is 10 megohms.

2) Set the FUNCTION switch at AL(ar)M, press the RESET button, and turn the COUNT switch on.

3) Rotate the TRIGGER control slowly from one extreme to the other while the ATTEN(uation) control is at each of the three settings (1, 10 & 100) on the AC side. Note that the instrument will count steadily over a certain range of the TRIGGER control for each ATTEN(uation) setting. Choose the highest ATTEN(uation) setting at which counting will continue when the TRIGGER control is rotated through an angle of at least 45 degrees.

4) Set the TRIGGER control at the midpoint of the arc over which counting occurs.

2.3.2 Effect of Input Controls. Figure 2 is a functional diagram of an input trigger channel.

The impedance at the input jack is 10 megohms in parallel with 40 $\mu\mu$f. This impedance may be reduced to match the source or to avoid capacitive

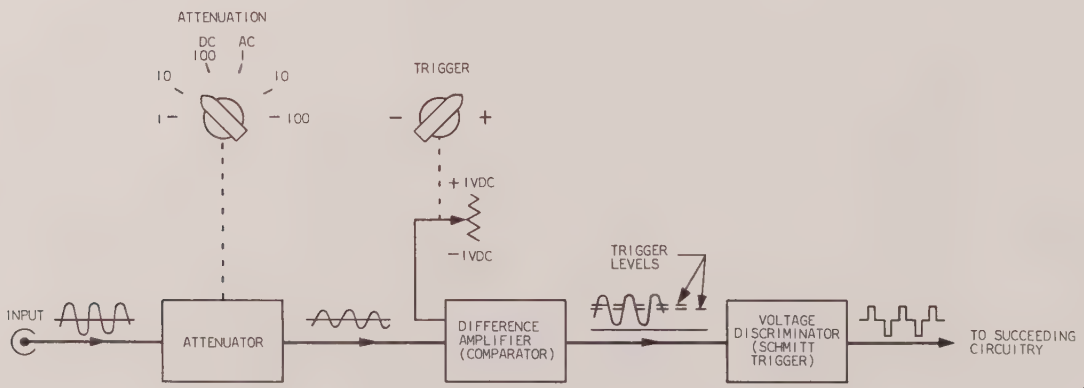


FIG. 2. Functional block diagram of an input trigger channel.

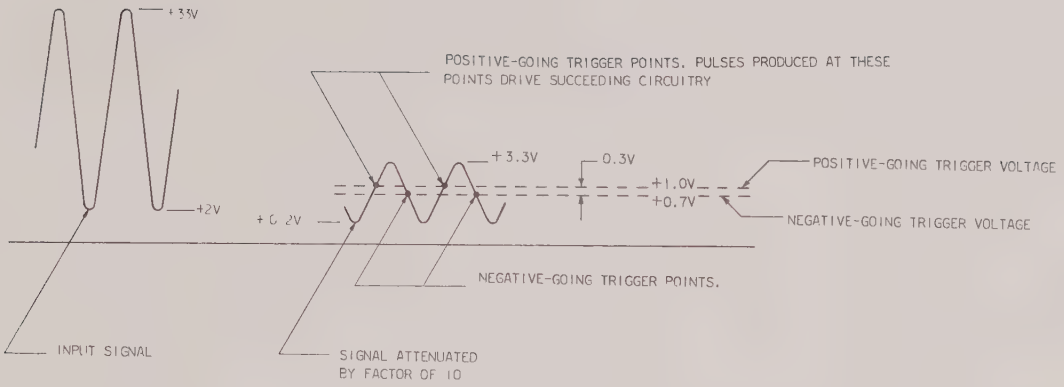


FIG. 3. How an input signal triggers channel output pulses.

pickup by attaching a "T" connector to the jack and adding resistors or capacitors in parallel. The input sensitivity is equal to 0.3 volts peak-to-peak times the setting of the ATTEN(uation) control. The input circuitry will take signal amplitudes up to 500 volts peak-to-ground without being damaged.

The attenuator divides the voltage introduced at the input jack by the setting of the ATTEN(uation) control. When the control is set to the "DC" side, the total input signal is attenuated and passed on. When the control is set to the "AC" side, the DC component is removed and only the AC component is attenuated and passed on. Frequencies as low as 1 cps will be passed in the "AC" positions.

Figure 3 shows how the varying voltage of the attenuated signal triggers channel output pulses. A pulse is produced each time the instantaneous voltage of the attenuated signal passes through the "positive-going" trigger voltage", providing it rises from below the "negative-going trigger voltage". Another pulse is produced each time the instantaneous attenuated voltage passes through the "negative-going trigger voltage", providing it drops from above the "positive-going trigger voltage". Only pulses triggered by positive-going voltage excursions affect the succeeding circuitry.

The two trigger voltage levels (positive-going and negative-going) are always separated by 0.3 volts, the effective hysteresis. Because

voltage excursions must travel through both levels to trigger a pulse, the sensitivity of the channel to the attenuated signal is 0.3 volts peak-to-peak. Both trigger levels are raised or lowered simultaneously (maintaining a 0.3 volt separation) when the TRIGGER control is rotated. This control will vary the levels from roughly -1 volt to +1 volt. Referring to Figure 2, note that the TRIGGER control actually raises or lowers the DC level of the input to the Voltage Discriminator. This action, however, has the effect of raising or lowering the trigger levels at the input to the Difference Amplifier.

The purpose of the input trigger channel is to produce a reliable pulse output representing that part of the input signal in which the operator is interested. This is achieved only when the ATTEN(uation) and TRIGGER controls are properly adjusted. Before attempting to adjust the controls, it is best to visualize the input waveform, noting the shape, AC amplitude, and DC level. The effect of various control settings is then relatively easy to calculate. Referring to Figure 3, note that:

1) If the attenuated signal has a small peak-to-peak amplitude, the trigger voltage levels may be set so high or so low that no output pulses are produced. In Figure 3, for example, if the "positive-going trigger voltage" were set at -0.5 volts (thus placing the "negative-going trigger voltage" at -0.8 volts), the attenuated signal with peaks at +0.2 and +3.3 volts would not intersect either trigger voltage level.

2) If the attenuated voltage variations are superimposed on a DC level, they may not come within the trigger voltage range. Thus, in Figure 3, if the input signal were not attenuated (or AC coupled) the negative peak at +2 volts would not intersect any possible trigger voltage level.

3) Modulation or variations in the DC level of the attenuated signal are least likely to cause missing of pulses, if the trigger voltages are set about halfway between the peaks of the signal.

4) Extraneous signals (noise, hum, modulation, drift, etc.) have the least effect on the time at which a pulse occurs when the channel is triggered on a steep portion of the waveform.

5) Noise below 0.3 volts peak-to-peak will not trigger extraneous pulses. Consequently, attenuating a signal carrying a given percentage of noise may eliminate the effect of the noise. For example, 1 volt peak-to-peak noise on a 6 volt peak-to-peak signal will trigger extraneous pulses. If the signal is attenuated by a factor of 10, the resulting 0.6 peak-to-peak signal will still trigger desired pulses dependably, while the resulting 0.1 volt peak-to-peak noise is well below the sensitivity of the channel.

6) Attenuating the input signal:

   a) Reduces the slope at all points

   b) Shifts the AC component nearer to ground potential if it is superimposed on a DC level.

   c) Increases the minimum peak-to-peak variation needed to trigger pulses (measured at the input jack) from 0.3 volts to 3 or 30 volts.

   d) Increases the range of possible trigger voltage setting on the input signal from ±1 volt to ±10 volts or ±100 volts.

Adjustment of ATTEN(uation) and TRIGGER controls should be made keeping the above characteristics in mind. When using any regular periodic input signal, consistent counting is a good indication that the controls are properly adjusted.

The point on an input waveform at which the input channel is triggered can be seen on an oscilloscope. Observe the control grid input to the voltage discriminator in the input channel (V303, pin 2). The waveform which appears in the amplified input signal together with small "notches" created on each slope as the channel is triggered. Rotating the TRIGGER control will cause these notches to move up and down the waveform. Some information about the position of the trigger voltage relative to the signal may be extracted from the instrument itself. The trigger voltages may be varied between the positive and negative peaks of an attenuated signal whose peaks lie in the range of -1 to +1 volts. As the trigger levels pass beyond the signal peaks, the pulse output of the channel will cease, and then these positions of the control can be noted.

2.4 OUTPUT CHARACTERISTICS

Each channel (A or B) produces the following outputs at the corresponding preset count.

1) A 50 volt step, going from -20 to +30 volts with respect to chassis ground, at an output impedance of 250 ohms (external load resistance must be at least 3500 ohms). This signal is available at the corresponding CATH(ode) FOL(lower) connector located on the rear panel of the instrument (see Figure 1).

2) Transfer of a dual set of form "C" relay contacts wired to terminals of the relay output connector as shown in Figure 4.

CANNON 22-19

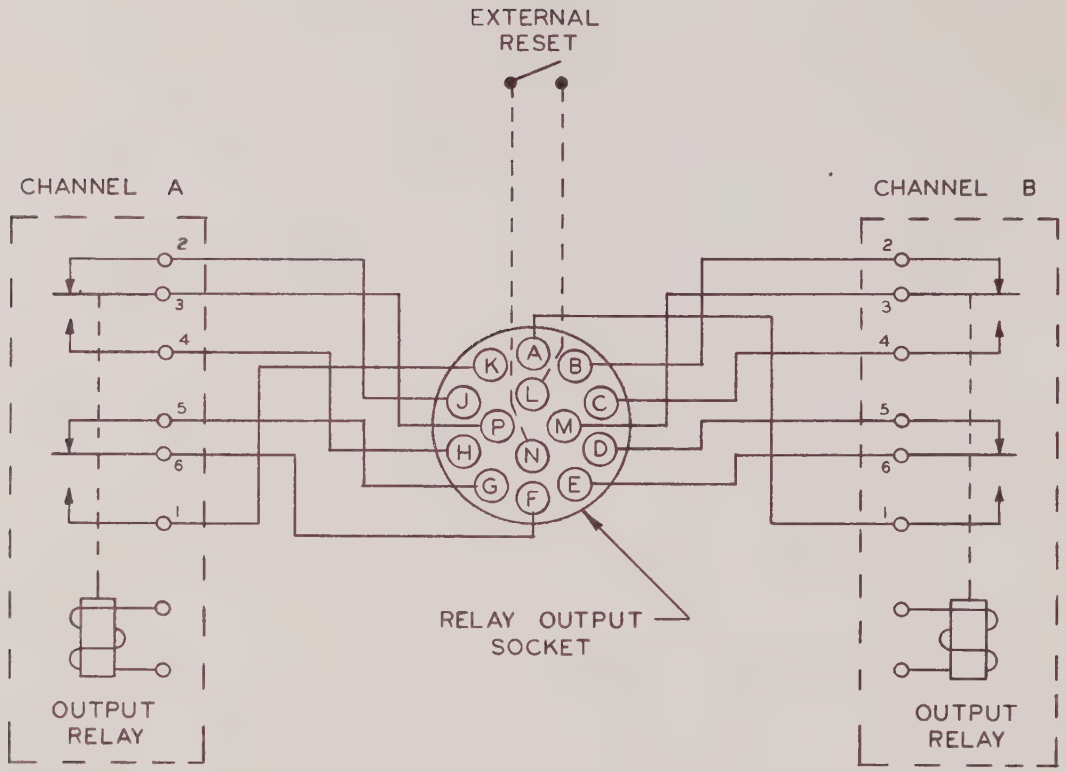


FIG. 4. How the output relays are wired to the output connector. Both relays are shown in the normally deenergized state.

Both signal and relay outputs operate in unison. That is, when the relay is deenergized, the potential at the CATH(ode) FCL(lower) jack is -20 volts with respect to ground; when the relay is energized, the potential goes up to +30 volts with respect to ground.

The duration of the outputs from each channel is determined by the setting of the corresponding output selector switch located inside the instrument on top of the chassis. When the switch is in the PULSE RELAY position, both outputs have a duration of 50 milliseconds. In the PULSE position, the relay does not function but the signal output provides a pulse of 30 microsecond duration. Finally, with the switch in the HOLD RELAY position, both outputs are sustained until the next time the corresponding preset count is reached (or the RESET button is pressed). In other words, the relay and signal output potential change to the alternate state on successive preset counts of the same channel (except in DUAL operation; see section 2.5.3).

2.5 DESCRIPTION OF THE OPERATING MODES

2.5.1 The AL(ar)M Function. In this mode of operation, the instrument produces an output from each channel when the corresponding preset count is reached, and continues to count as long as the input signal is applied. To obtain another operating cycle, it is, therefore, necessary to reset the instrument. This can be done either by pressing the RESET button on the front panel, or by externally shorting pins L and N of the relay output connector.

In this mode, the "A" preset switches must always be set for a lower number than the "B" preset switches.

2.5.2 The ALT(ernate) Function. In this mode, the instrument operates as follows:

When the "A" preset count is reached, an output is produced in the "A" channel. Simultaneously, the instrument resets its counters to zero and immediately starts counting again without losing a count. This time, however, the unit continues to count until the "B" preset number is reached. When that happens, the unit produces an output in the "B" channel and automatically recycles to the "A" channel, again with no loss of counts. The instrument thus continues to alternate between the two channels as long as the input signal is applied.

In this mode, the "A" and "B" preset switches can be independently set to any number from 1 up to the capacity of the instrument.

2.5.3 The DUAL Function. In this operating mode, the instrument produces an output in the "A" channel when the corresponding preset count is reached and continues to count without resetting until the "B" preset number is reached. When that happens, the unit produces an output in both the "A" and the "B" channel, resets its counters to zero, and starts counting again with no count loss. The instrument continually repeats this same process while the input signal is applied.

This mode of operation requires that the "A" preset switches be set for a lower number than the "B" preset switches

2.5.4 The "A" and "B" Functions. In either of these modes, the instrument operates only in the channel selected with the FUNCTION switch. When the corresponding preset count is reached, the unit produces an output in that channel, resets its counters to zero, and thus recycles as long as the input signal is applied.

2.6 OPERATING PROCEDURE

1) Couple the input signal to the coaxial connector on the front panel of the instrument

2) Set the ATTEN(uation) and TRIGGER controls as described in section 2.3. After these controls have been properly set, turn the COUNT switch off.

3) Set the FUNCTION switch for the required operating mode.

4) Make the proper output connections and select the required output signal duration for each channel (see section 2.4).

5) Set the "A" and "B" preset selectors for the count at which an output from the corresponding channel is to be obtained.

NOTE

When operating in the AL(ar)M or DUAL mode, the "A" preset switches must be set for a lower number than the "B" preset switches.

6) To start the counting process, press the RESET button to clear the instrument and turn the COUNT switch on.

7) To begin another operating cycle in the AL(ar)M mode after the "B" preset count has been reached, press the RESET button or produce an external short between pins L and N of the relay output connector.

3. SERVICING

3.1 ADJUSTMENTS

3.1.1 Adjusting the Regulated 120 Volt Supply. With an accurate voltmeter, measure the supply voltage at the "+120V" test jack on the rear panel of the instrument. If necessary, adjust the control labeled +120V ADJUST for a reading of 120 volts.

3.1.2 Adjusting the Input Attenuator. The two ceramic trimmer capacitors on the input attenuator assembly must be kept in proper adjustment to prevent distortion of the input signal. With the counter chassis upside down and the attenuator shaft pointing toward the viewer, the capacitor on the right side of the attenuator is C303 and that on the left is C302. To adjust these trimmers, proceed as follows:

1) Apply a 500 cps square wave signal at the front panel input jack, and observe the corresponding amplifier output at pin 1 of V302 with a 100 kc band-width oscilloscope.

2) Turn the ATTEN(uation) control to 10 on the AC side, and adjust the input signal to about 1 volt peak-to-peak.

3) Adjust the TRIGGER control to any position in which the channel triggers.

4) Adjust C303 for a square wave output.

5) Turn the ATTEN(uation) control to 100 on the AC side and adjust the input signal to about 10 volts peak-to-peak.

6) Adjust C302 for a square wave output.

MODIFICATION A

In this modification, a high speed relay with mercury-wetted contacts is used in place of the standard output relay. The relay is wired to the output connector as shown in Fig. A-1.

Total current through the four stationary front and back contacts should not exceed 5 amperes rms on a continuous basis. In addition, for long service life, the following ratings apply:

1) For any single contact within the relay the current immediately prior to opening should not exceed 5 amperes.

2) The voltage across the contacts immediately prior to closing should not exceed 500 volts.

3) The product of current at opening and voltage at closing as described above should not exceed 250 volt-amperes. This condition defines the current-voltage relations permissible for currents less than 5 amperes in the voltage range from 50 to 500 volts.

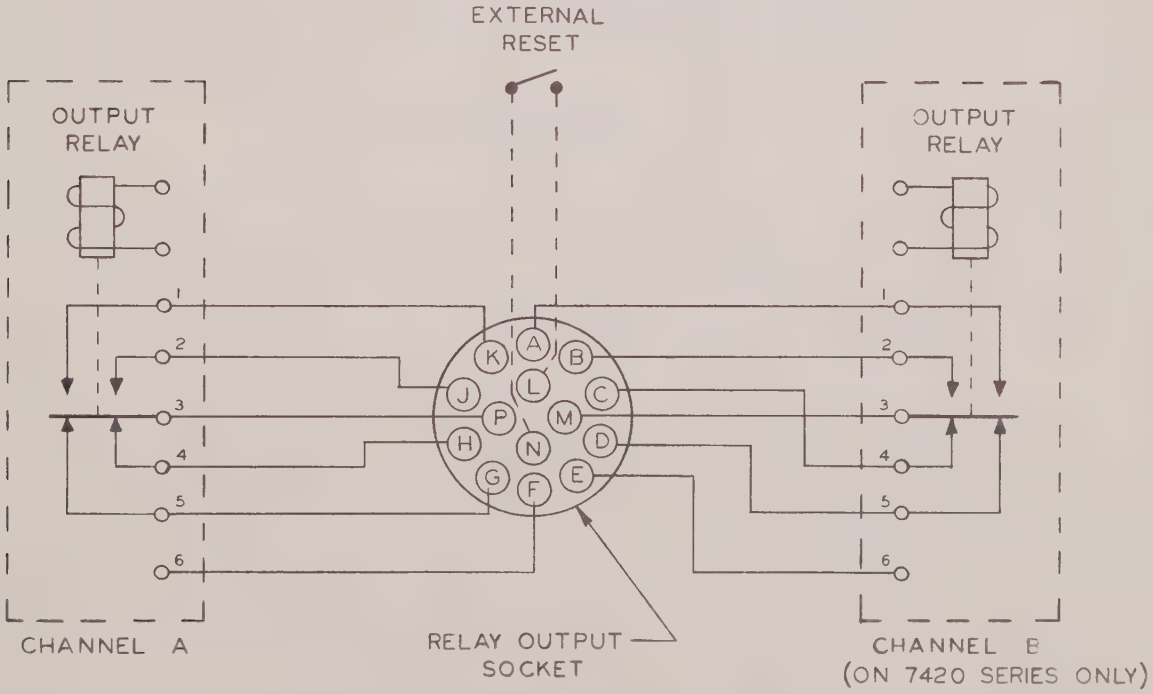


FIG. A-1. How the output relays in Modification A are wired to the output connector. Both relays are shown in the normally deenergized state.

Absorption Circuit. For the absorption circuit (see Fig. A-2), the preferred values of R and C can be determined by the following equations, except where indicated below:

$$C = \frac{I^2}{10} \text{ microfarads} \qquad (A)$$

$$R = \frac{E}{10I(1 + 50/E)} \text{ ohms} \qquad (B)$$

Where I = load current in amperes immediately prior to opening of contacts. E = source voltage immediately prior to closing of contacts.

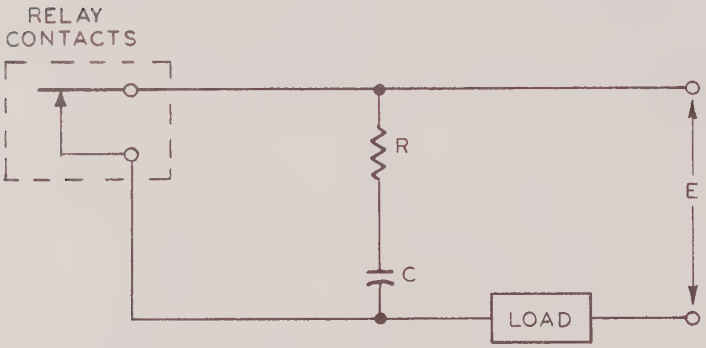


FIG. A-2. Absorption network to be used with the output relay of Modification A.

The calculated value of C is required in all cases, if E is less than 50 volts, and I less than 2.5 amperes, R may be omitted. For all other conditions, R shall be determined by equation (B) but must not be less than 0.5 ohms.

For E up to 70 volts, R may be three times value in (B).
For E at 100 volts, R shall be within ±50% of value in (B).
For E at 150 volts, R shall be within ±10% of value in (B).
For E greater than 150 volts, equation (B) should be followed closely.

Load and Wiring Protection. The "break" action of this relay is extremely rapid, resulting in very large peak voltages across the load. For protection of the load and circuit wiring, these peak voltages can be reduced to safe levels by increasing C in equation

(A) above the minimum value required for contact protection. The appropriate value can be determined by measuring peak values within the first few milliseconds after break of the contacts.

Characteristically, when these relays are operated at rates of less than one per second, all four stationary contacts and the armature may be electrically connected during the transfer of the armature from one pair of stationary contacts to the other. This "bridging" of the contacts is caused by the wetting action of the mercury. If "bridging" occurs, it should not last more than a millisecond. If the application of this relay involves a source of power across the front and back contacts, fulfill the contact protection requirements and do not exceed current ratings. In some cases, a current limiting impedance in the power circuit may be required.

Mounting Position. Optimum performance is obtained when this relay is operated in a vertical position. Somewhat decreased performance is obtained for operation at small angles off the vertical position. The drive on the operating winding as well as the departure of the relay mounting position from a true vertical position affect the "bridging-transfer" time of this relay. Mounted at an angle other than vertical, the departure should not exceed 30 degrees from the vertical. Under such conditions, and for operating rates of less than one per second, any "bridging" should not last more than one millisecond.

Modifications

Modified instruments are identified by a letter or letters after the model number. For example, the Model 7150D is a standard Model 7150 EPUT® Meter modified as described below under "Modification D". An instrument may be modified in more ways than one; for instance, the Model 7150DK is a Model 7150 changed in accordance with both "Modification D" and "Modification K".

MODIFICATION B

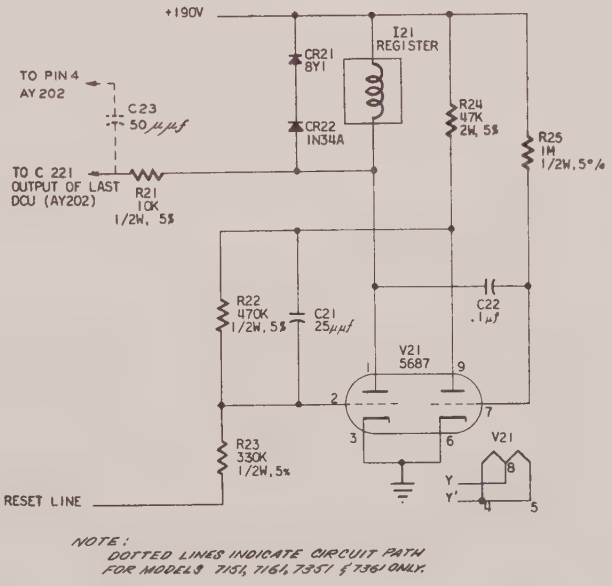
This consists of adding a dual-purpose decimal counting unit to 7000 series instruments which do not normally contain such a unit. Depending on the position of the FUNCTION switch, this DCU either extends the count capacity by a factor of 10 or divides the frequency of the pulses which start and stop counting by 10.

MODIFICATION C

This consists of the addition of a mechanical register which will extend the counting capacity of any 7000 series instrument by a factor of 10^3. Instead of using the electronic signal which resets the DCU's, the register is reset by a small lever on the front panel directly below the mechanical count-indicating dials.

On instruments with "X10" positions on the FUNCTION switch, the indicating panel of the DCU Divider (AY201) is not exposed to view when the C modification is made. The digit normally displayed by AY201 is shown at the right-hand digit of the register dial. AY202, the last exposed DCU next to the register, drives V21, a one-shot multivibrator. Each time this is activated a count is recorded on the mechanical register, the coil of which is the multivibrator plate load.

When AY202 resets, a counting pulse may appear in the output. To counteract this, the reset line is connected to control-grid pin 2 of V21, so that whenever a reset pulse causes a count from AY202 to appear on the plate pin 1 of V21, the reset pulse also appears at the grid. The two pulses, opposite in polarity, counteract each other so that no count is recorded at the register.

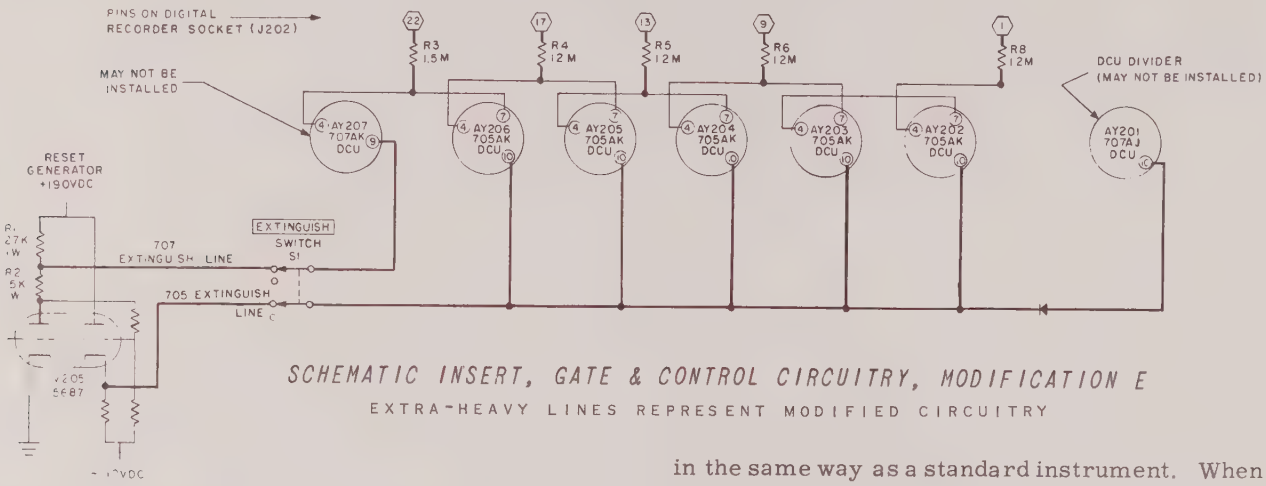


SCHEMATIC INSERT, GATE & CONTROL CIRCUITRY, MODIFICATION C

MODIFICATION D

This consists of substituting a 100Kcs heated crystal in the oscillator of the clock-pulse generator in place of a 100Kcs unheated crystal. This modification is applicable only to 7000 Series instruments which normally contain an unheated crystal (for example, Models 7150 and 7250). The heated crystal has a stability of 1 part in 10^6 per day as compared with a stability of 1 part in 10^5 per day for the unheated crystal.

MODIFICATION E



SCHEMATIC INSERT, GATE & CONTROL CIRCUITRY, MODIFICATION E

EXTRA-HEAVY LINES REPRESENT MODIFIED CIRCUITRY

This consists of replacing the standard decimal counting units with DCU's whose indicating bulbs can be extinguished automatically while the instrument is actively counting. With automatic extinguishing, the indicating bulbs light only at the end of each counting period to display the result.

The accompaning schematic insert shows how the circuitry of the standard instrument is modified. The voltage which extinguishes the DCU bulbs is supplied by the reset generator while it functions as usual in the standard automatic operating cycle. Both "extinguish lines" leading from the reset generator are at a relatively negative voltage at all times except during the display period. The relatively-negative voltage applied to the DCU's prevents the neon bulbs from lighting. The relatively-positive voltage on the "extinguish lines" during the display period permits the bulbs to light.

The EXTINGUISH toggle switch is located on top of the counter chassis. It may be exposed by lifting the top lid of the instrument. When this switch is closed the indicating bulbs are automatically extinguished as described above. When the switch is open the counter operates in the same way as a standard instrument. When counting is controlled manually (that is, by moving the FUNCTION switch from OFF to COUNT and back again) the EXTINGUISH switch should be open. Under manual control no automatic display period occurs, so the reset generator always supplies a voltage which would extinguish the indicating neons if connected to the DCU's.

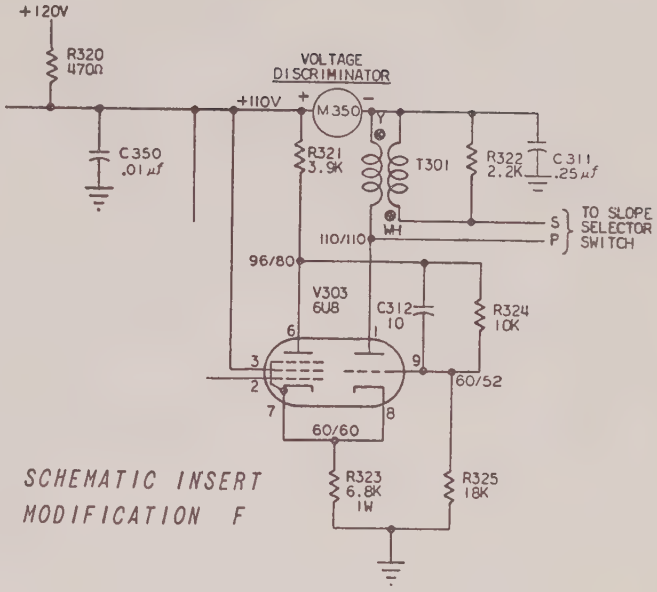
All 705AH DCU's in the standard instrument are replaced by 705AK DCU's. Pin 10 of the DCU socket is connected to an "extinguish line" instead of to a pin in the DIGITAL RECORDER socket. The DIGITAL RECORDER pin which ordinarily connects to pin 10 is connected instead to pin 4 through a 1.2 megohm resistor.

If the standard instrument has a maximum counting rate of 1 Mcs, it contains a 707AH DCU. This DCU is replaced by a 707AK DCU. An "extinguish line" is connected to pin 9 of the DCU socket, and the DIGITAL RECORDER pin which is ordinarily connected to pin 9 is connected instead to pin 4 through a 1.5 megohm resistor.

If the standard instrument is equipped with a DCU used as both a counter and a frequency divider (Model 705AJ), an "extinguish line" is connected to pin 10 of its socket.

MODIFICATION F

This consists of making modifications B, D and R plus adding a TRIGGER STATE meter to the E/UT input channel. The meter aids in adjusting the TRIGGER VOLTAGE control. The operator should adjust this control until the meter pointer stays in the center green region.



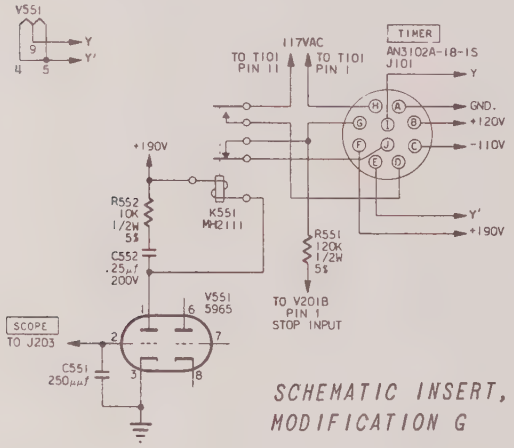
SCHEMATIC INSERT
MODIFICATION F

The TRIGGER STATE meter actually indicates the plate current flowing in the output triode of the voltage discriminator in the E/UT channel. This stage has two stable states: cut-off and conducting heavily. When the triode is cut-off, the meter indicates zero; when it is conducting, the meter is deflected to approximately full scale. The triode is triggered from one state to the other and back again by each input signal cycle. If the input frequency is above 10 cps the inertia of the meter will cause it to indicate the average plate current. A meter reading in the center green region indicates that the triode is cut-off half the time and conducting the other half. Under these conditions the channel produces the most reliable pulse output to be counted on the DCU's.

MODIFICATION G

This modification provides connections so that an external timer can be used to extend the sampling time of the counter. The labeling of J101 is changed from "ACCESSORY" to "TIMER". This socket provides 117 volt ac for operating the timer motor and it provides ground and Control Binary stop-input pin connections to the time-delay switch in the timer.

The G Modification functions with a timer in this manner. The timer dial is set to indicate a certain

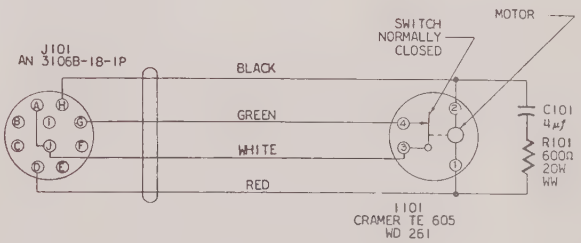


SCHEMATIC INSERT, MODIFICATION G

interval of time. A switch in the timer grounds the stop-input pin (pin 1, V201B) of the Control Binary (V203), so that once the counter starts counting it will not stop until the stop-input pin is ungrounded. The Relay Control tube (V501) conducts and energizes relay K501 when the Signal Gate (V204) "opens". (V501 is caused to start and stop conducting by the same signals that "open" and "close" the Signal Gate--that is, the output of the Control Binary.) When the relay energizes, it closes the contacts which supply 117 volts ac to energize the timer motor. After the pre-determined time interval, the time switch opens, and the Control Binary stop-input pin is removed from ground. The next clock pulse causes the Control Binary to "close" the Signal Gate and cut off the Relay Control tube (V501). K501 is de-energized, its contacts open and remove the power from the timer motor. At this point, the timer resets.

When the external timer is not used, remove the cable from the TIMER socket and the counter will operate normally.

The modified instrument is designed to be used with the Model 806 Timer. The timer will extend the 10-second automatic counting period to 20, 30, 40, 50 or 60 seconds. To install, simply connect timer plug to the TIMER socket at the rear of the counter. When operating, be sure the counter is set up to generate 10-second automatic counting period; that is, with the FUNCTION switch at E/UT x 10 and the TIME switch at "1". Set the timer to approximately 5 seconds less than the total counting period desired. Adjust the counter display time to one second or longer. If you find occasion to reset the instrument manually before the expiration of the extended counting period, depress the RESET button repeatedly until you see that the running pointer has returned to its starting position.

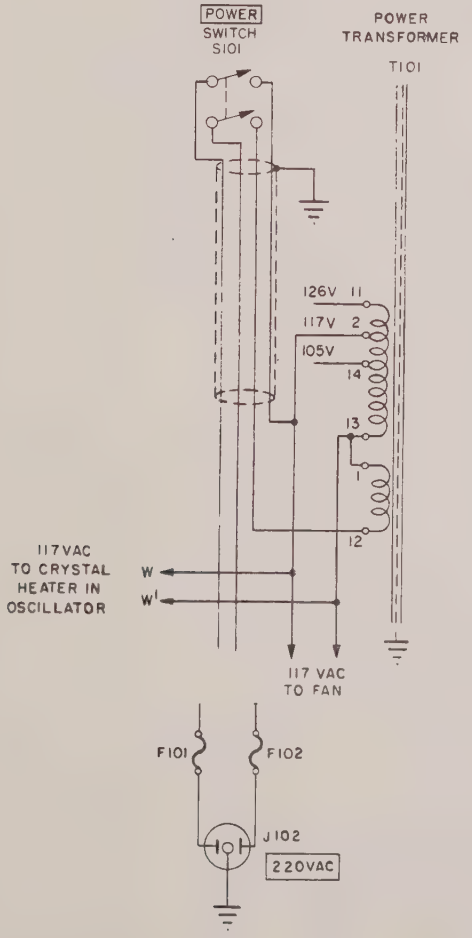


TIMER SCHEMATIC DWG.NO. 806 A 1

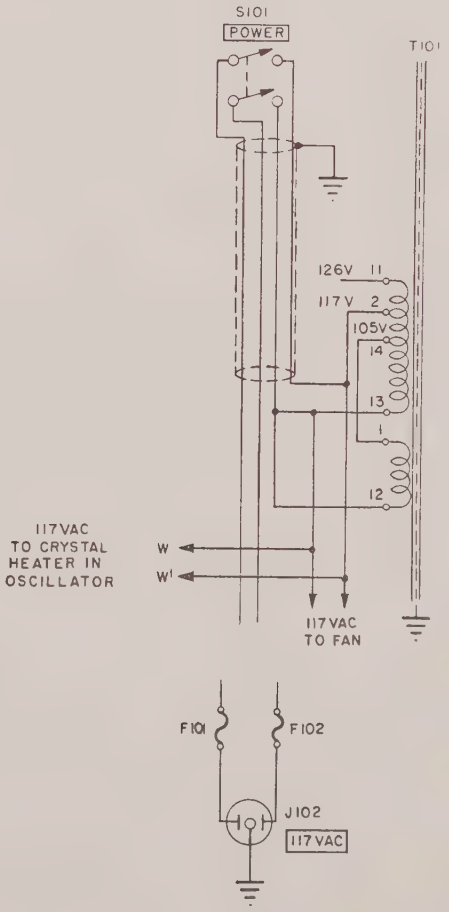
MODIFICATION H

This consists of modifying the instrument so it can be operated off a 220-volt line. The standard 117-volt power transformer is replaced by transformer having two primary windings, a 117-volt winding and a 105-volt winding. As shipped, these windings are connected in series so that when the instrument is connected to a 220-volt line, the proper voltage appears across each winding. The schematic insert below shows the modified circuitry. The line fuses (F101 & F102) in the standard counter have been replaced by fuses of one-half the standard current rating. Note that the crystal oven in the oscillator will no longer begin heating as soon as the instrument is plugged in, but will heat only when the POWER switch is on.

An instrument modified to operate on 220 volts can be reconverted to operate on 117 volts by changing the connections to the primary of the power transformer (T101) and replacing the line fuses. To do this break the connection between transformer terminals 1 and 13 and connect terminal 1 to terminal 14 and terminal 13 to terminal 12. Replace line fuses F101 and F102 with fuses of twice the current rating of those installed. The resulting circuitry is shown in the schematic insert below. Note that the 117-volt winding is connected across the line and that the 105-volt winding is connected in parallel with part of the 117-volt winding.



SCHEMATIC INSERT, POWER SUPPLY, MODIFICATION H



SCHEMATIC INSERT, POWER SUPPLY, MODIFICATION H RECONVERTED TO OPERATE ON 117 VOLTS AC.

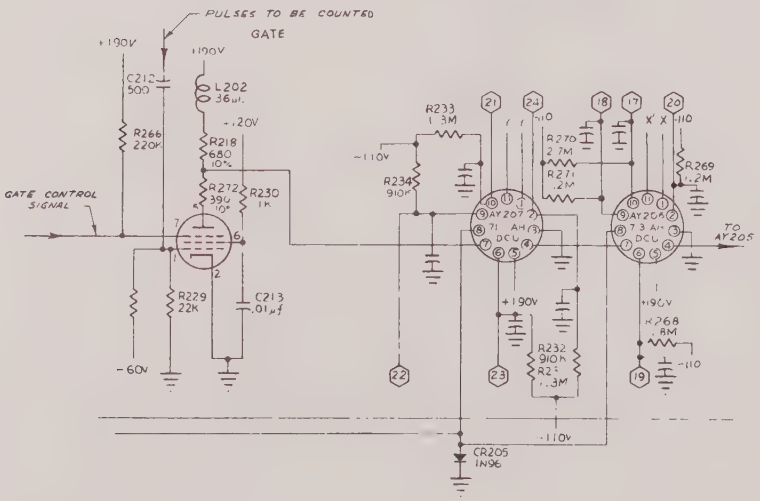
MODIFICATION J

The purpose of this modification is to increase the maximum counting rate from 1Mcs to 2Mcs. To do this the first two DCU's in the counting chain are replaced with higher speed units and both input channels are modified to extend the frequency range of each to 2Mcs.

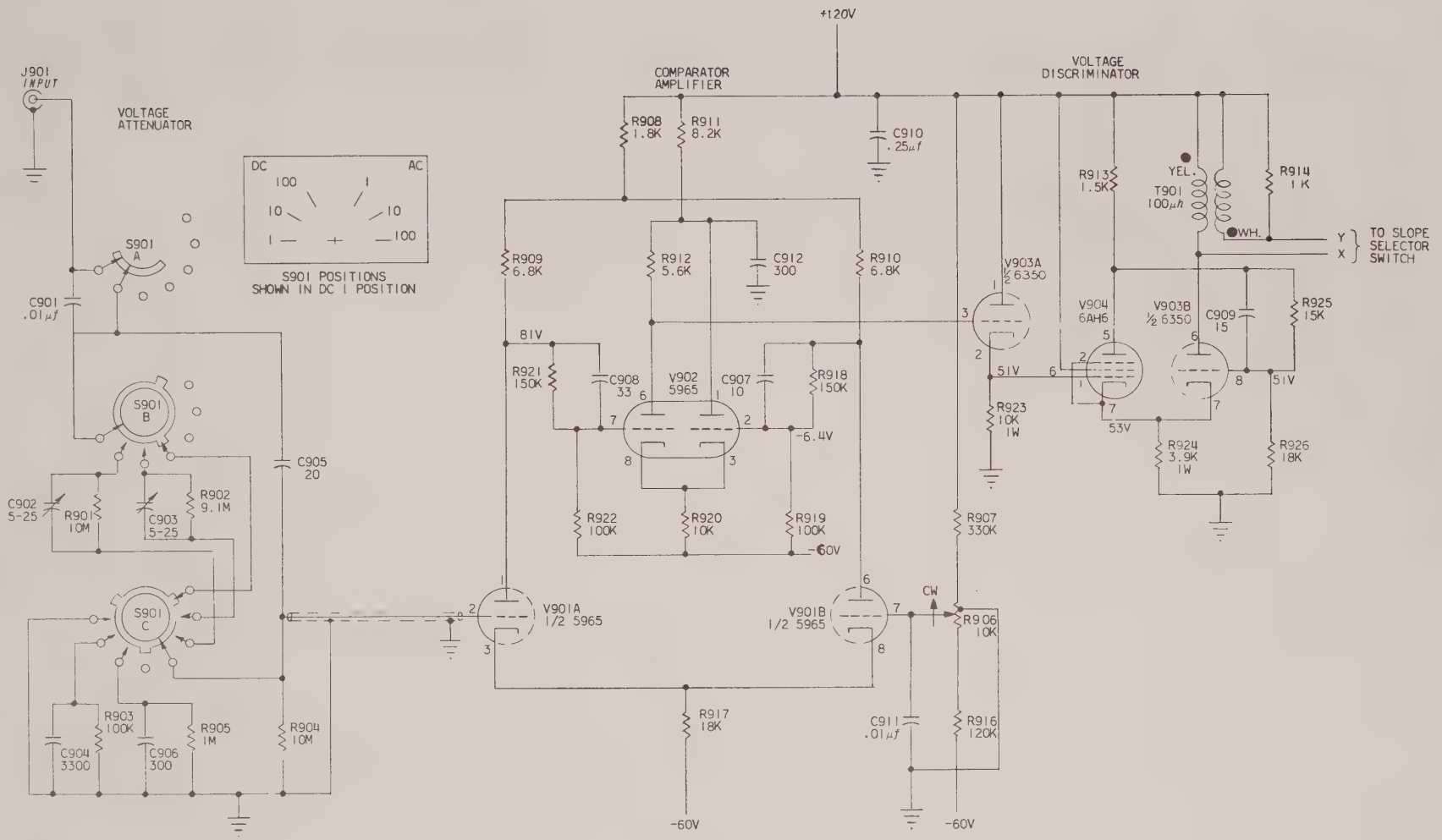
The new DCU's are the Model 711AH, which replaces a Model 707AH as AY207, and the Model 713AH, which replaces a Model 705AH as AY206. Instruction manuals on the new DCU's are located at the rear of this booklet. To accomodate this change, the circuitry surrounding the new DCU's and the gate circuitry is modified slightly, as shown in the accompanying schematic insert.

The frequency response of the input channels has been extended by inserting a cathode follower between the difference amplifier and the voltage discriminator. A schematic diagram of the modified channel appears on the following page.

(NOTE: On the Model 7360 Universal EPUT® and Timer, this modification includes the addition of an accessory socket as described under "MODIFICATION U".)



'SCHEMATIC INSERT, GATE & CONTROL CIRCUITRY
MODIFICATION J



NOTE:

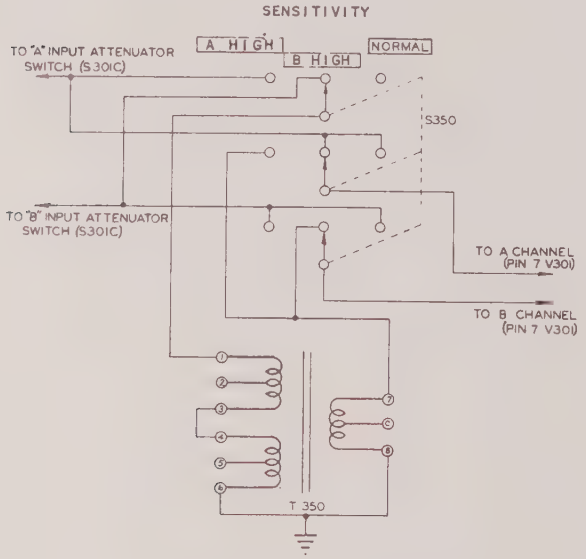
RESISTORS: 1/2 WATT, 5% UNLESS OTHERWISE NOTED.

CAPACITORS: IN μμf UNLESS OTHERWISE NOTED.

SCHEMATIC DIAGRAM
INPUT TRIGGER CHANNEL
MODIFICATION J.
DWG NO. 55710-7

MODIFICATION K

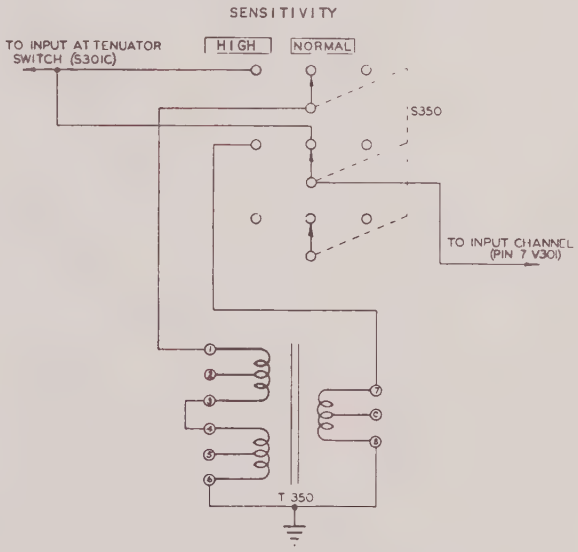
The purpose of this modification is to increase the input sensitivity of the counter from 100mv rms to 5mv rms with a resultant decrease in input impedance. This is done by adding a step-up transformer in the input circuit. The operator may insert and remove the transformer by positioning a front-panel sensitivity switch.



WIRING FOR TWO INPUT CHANNELS

If the modified instrument has two input channels, the front-panel switch will have three positions marked "NORMAL", "A HIGH" and "B HIGH". At NORMAL the transformer is not connected to either input channel, and the instrument functions just as though it had not been modified. At A HIGH the step-up transformer is connected between the attenuator and the input grid of the A channel. At B HIGH the transformer is inserted between the B attenuator and the input grid of that channel. If the modified instrument contains only one input channel the front-panel switch has only two positions; one marked "NORMAL", the other marked "HIGH".

Do not insert the transformer in an input channel unless the input signal is below the normal sensitivity of the counter. With the transformer connected, the ATTENUATION control should be at DC-1. Under these conditions the input impedance will vary with frequency, rising from at least 300 ohms at 5cps to approximately 25K ohms at 10Kcs. Sensitivity is at least 5mv over this frequency range.



WIRING FOR ONE INPUT CHANNEL

MODIFICATION L

This modification makes it possible to set the digital divider number (N) on a preset counter (Model 7151, 7161, 7351, or 7361) either at the front panel of the instrument or at a remote point. The modification includes the following changes made in a standard instrument.

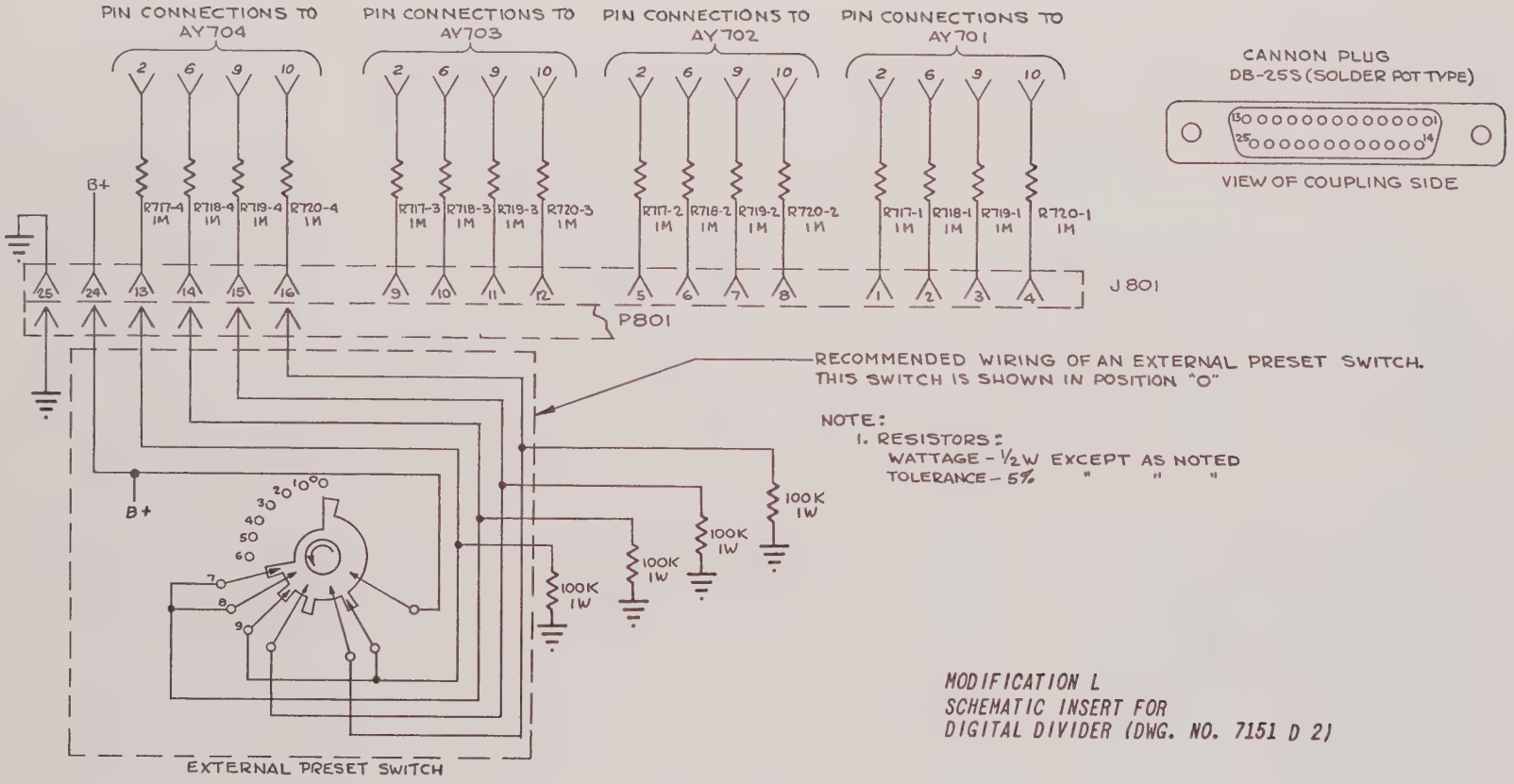
A 25-pin female connector (J801) has been added on the rear of the chassis. This connector is wired to the sockets of the digital divider DCU's as shown on the schematic insert for this modification.

One end of a length of ribbon cable has been wired to the preset switches mounted on the instrument. The other end of this cable, terminated by a 25-pin male connector (P801), extends from the rear of the unit and plugs into the chassis connector.

Another 25-pin male connector is provided for wiring to the external preset switches (see schematic insert).

To control the digital divider from the remote preset switches, unplug the ribbon cable connector at the right rear of the chassis and plug in the connector wired to the remote unit. To return control of the divider to the front panel thumbswitches, merely reverse the procedure.

See following page for schematic diagram.

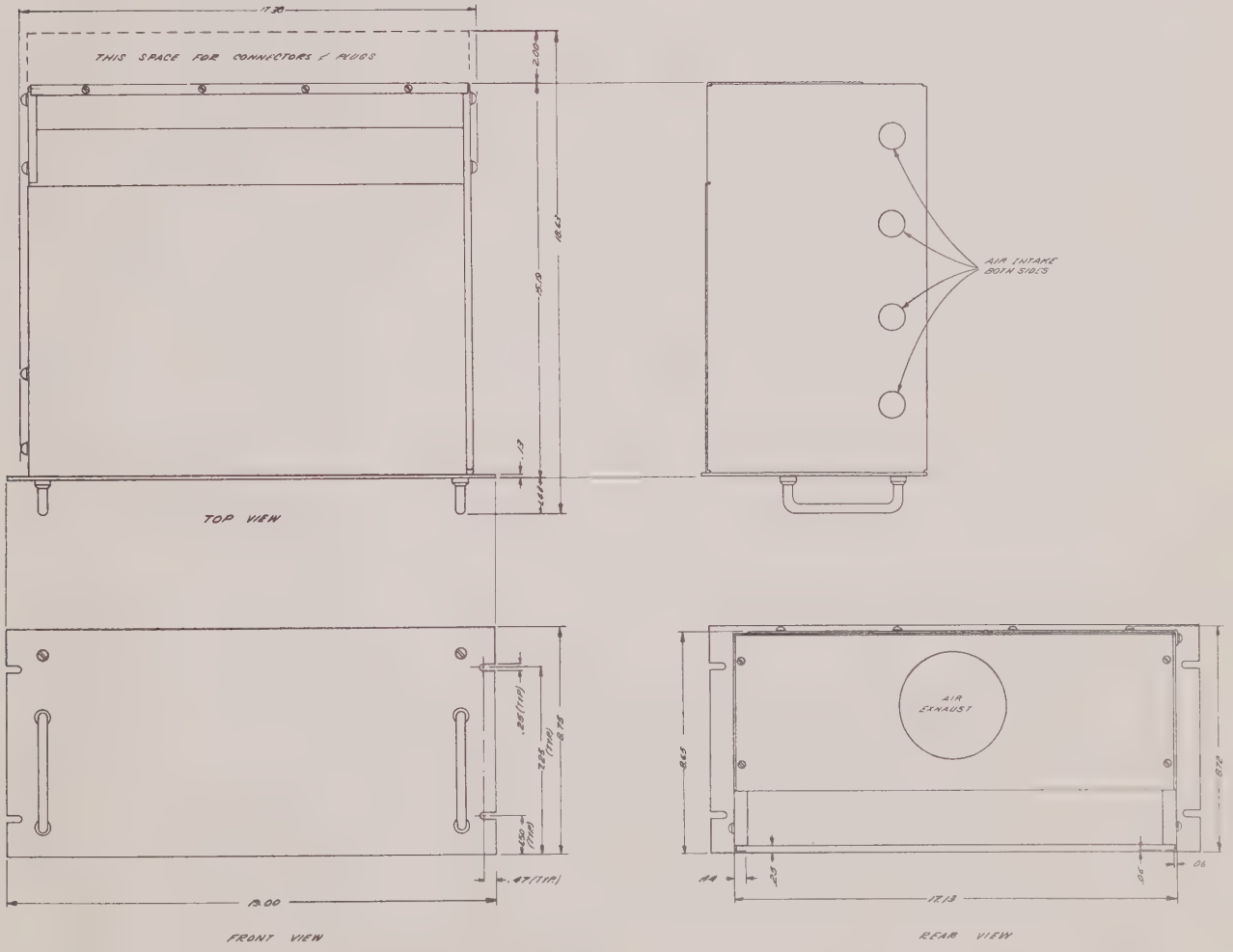


MODIFICATION L
SCHEMATIC INSERT FOR
DIGITAL DIVIDER (DWG. NO. 7151 D 2)

MODIFICATION R

In this modification, the instrument is supplied without a cabinet but with a dust cover on top of the chassis. This allows the unit to be installed and operated in a standard relay rack. Mounting dimensions are as shown in the figure below.

Cooling air is drawn into the unit through a set of intake ports near the bottom of both sides of the chassis. These should remain relatively unobstructed to allow a free flow of air. The same holds true for the exhaust opening in the back of the unit.



RACK MOUNTING DIMENSIONS,
MODIFICATION R

MODIFICATION T

This consists of the V modification plus a half-second clock-pulse interval in place of the usual one-second interval. The last stage of the Frequency Divider Chain is modified from a divide-by-ten to a divide-by-five stage. This is done by changing the value of timing capacitor C617 from 0.47μfd to 0.25μfd. The extreme clockwise position of the TIME-SECONDS switch is also changed to read ".5". When using an instrument with this modification keep in mind that the maximum sampling time available is 0.5 seconds, not 1.0 seconds.

MODIFICATION U

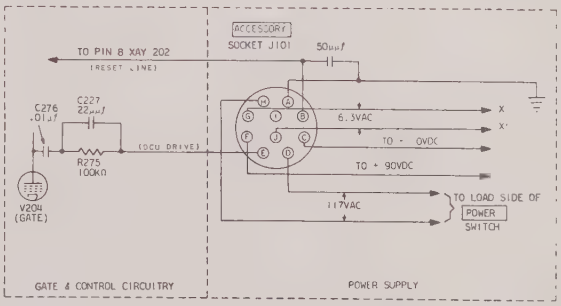
This consists of adding an accessory socket to the rear panel. The socket carries ac and dc voltages which can be used to power auxiliary equipment.

Pin No.	Voltage
A	Ground
B	+120v dc reg.
C	-110v dc unreg.
D	Spare
E	6.3v ac (gnd. side)
F	+200v dc unreg.
G	Spare
H	Spare
I	6.3v ac (hot side)
J	Spare

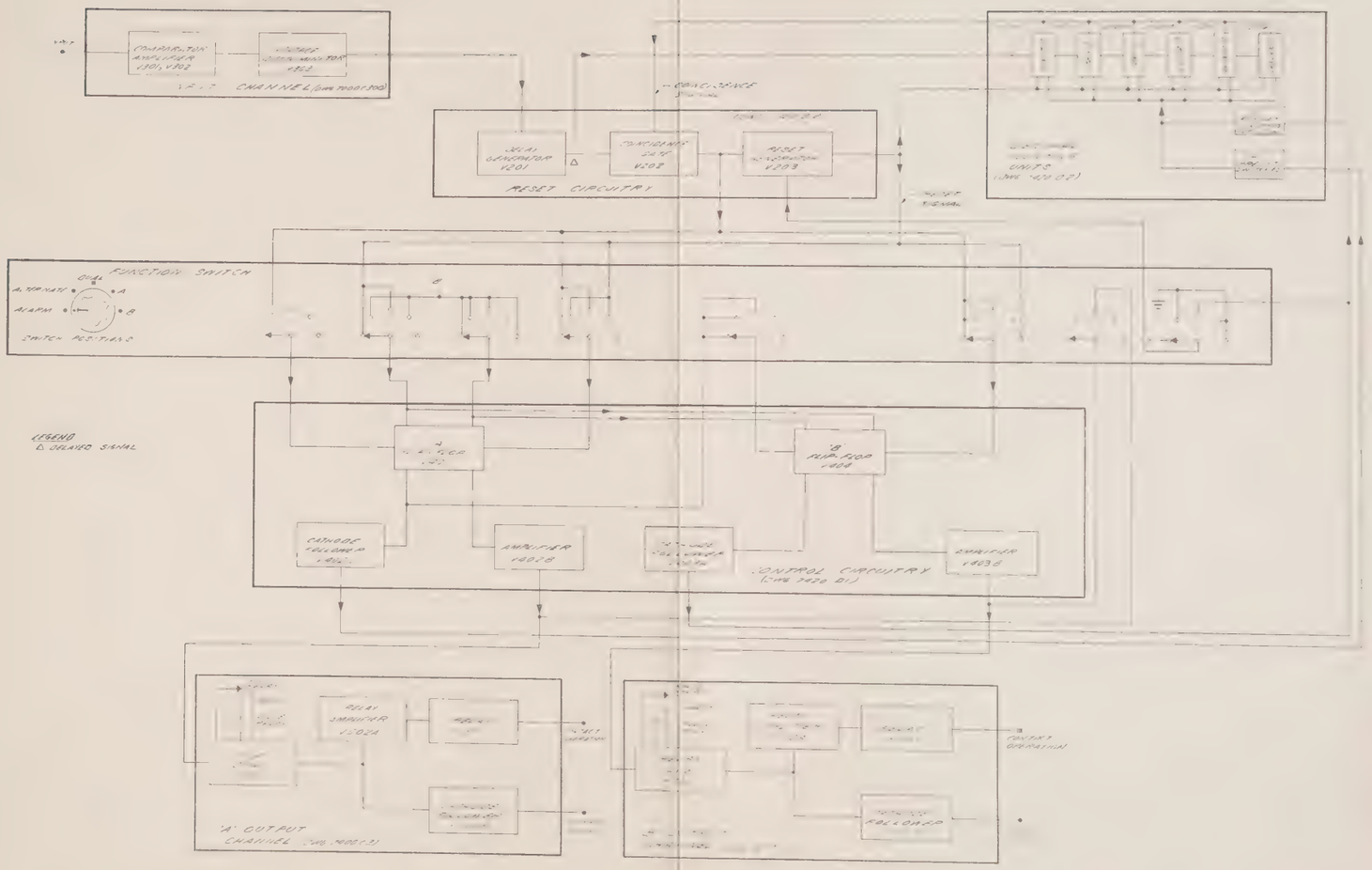
MODIFICATION V

The V modification provides DCU Drive and Reset signals, as well as power at the ACCESSORY socket (J101) for operating a remote indicator consisting of several cascaded DCU's. The DCU drive signal is taken from the plate of the Signal Gate (V204). The signal is passed through a network which reduces its amplitude and its output impedance before it reaches the ACCESSORY socket. The Reset signal is taken directly from the reset line (pin 8 of the DCU's). In addition, B+ and B- voltages are available at J101, as well as 117 volts ac to power a fan and a filament transformer.

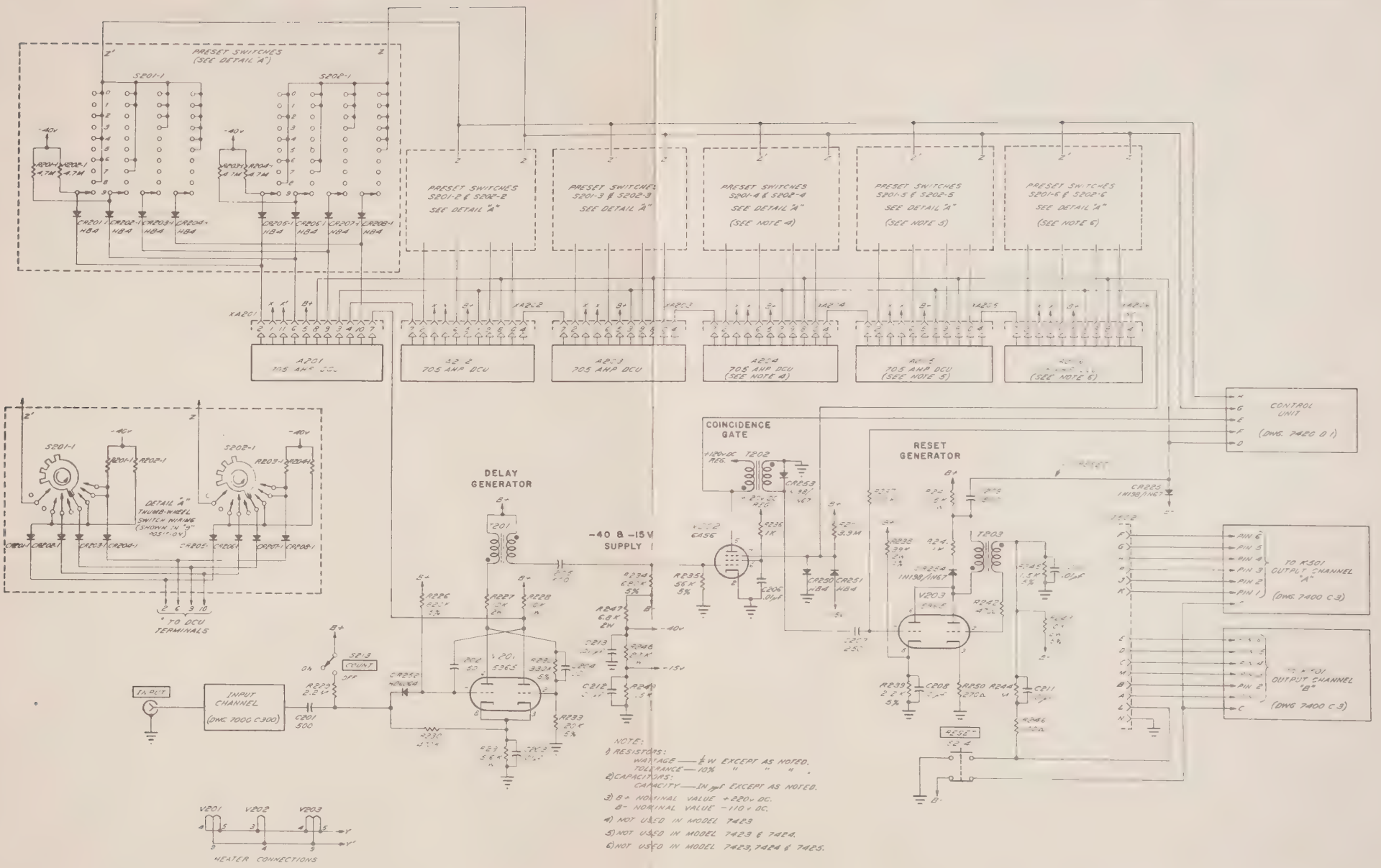
The DCU's may be removed from the counting instrument and placed in the remote indicator. If this is done there will no longer be a signal at J202, the DIGITAL RECORDER socket, for operating an accessory recorder. With the remote indicator in use, operate the counting instrument in the usual manner. When the remote indicator is not used, disconnect the indicator cable from the ACCESSORY socket.



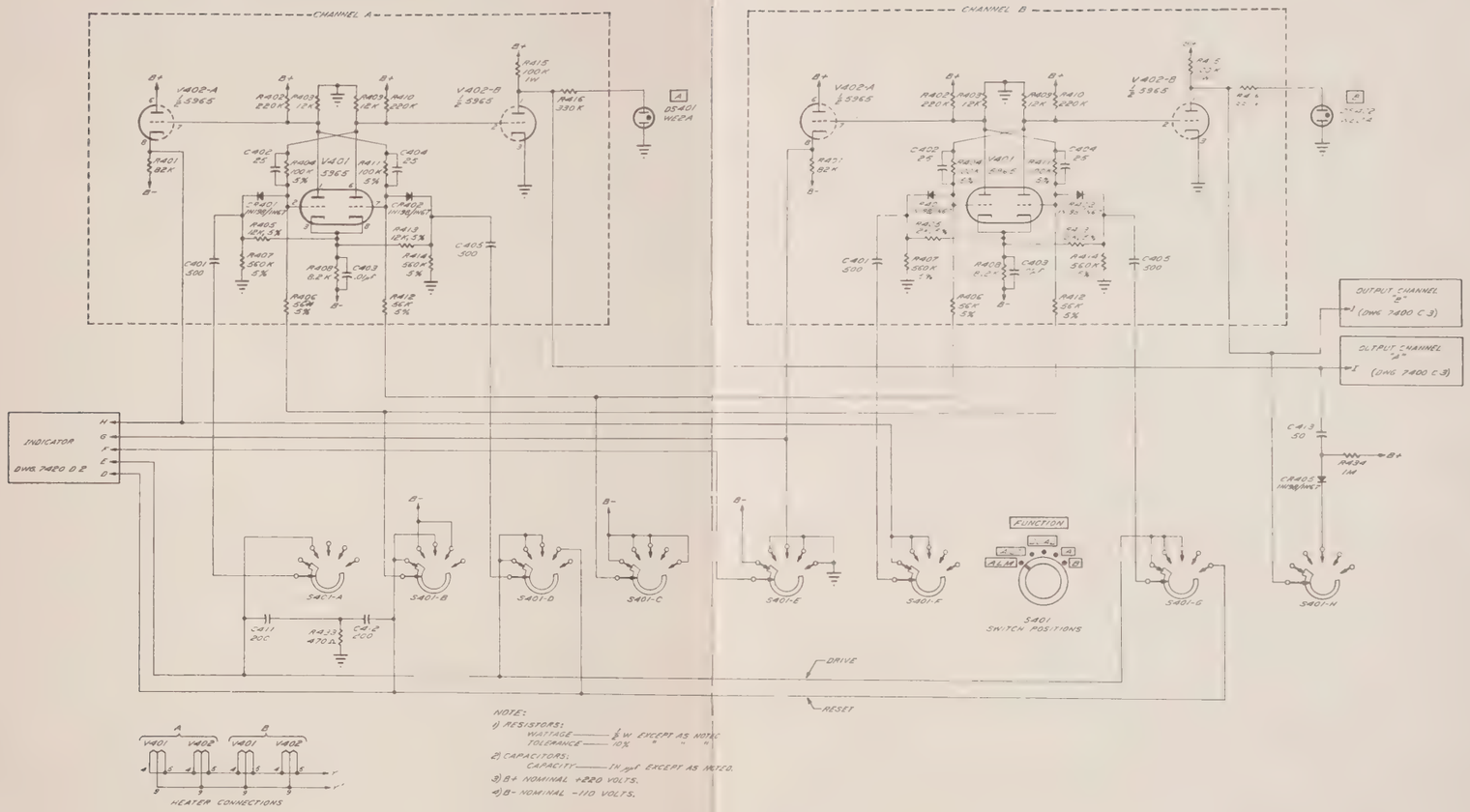
SCHEMATIC INSERT, MODIFICATION V



BECKMAN/BERKELEY DIVISION
DWG. NO. 7420 D 16


PRESET SWITCHES
(SEE DETAIL "A")
S201-1
S202-1
PRESET SWITCHES S201-2 & S202-2 SEE DETAIL "A"
PRESET SWITCHES S201-3 & S202-3 SEE DETAIL "A"
PRESET SWITCHES S201-4 & S202-4 SEE DETAIL "A" (SEE NOTE 4)
PRESET SWITCHES S201-5 & S202-5 SEE DETAIL "A" (SEE NOTE 5)
PRESET SWITCHES S201-6 & S202-6 SEE DETAIL "A" (SEE NOTE 6)
A201 705 AMP DCU
A202 705 AMP DCU
A203 705 AMP DCU
A204 705 AMP DCU (SEE NOTE 4)
705 AMP DCU (SEE NOTE 5)
(SEE NOTE 6)
CONTROL UNIT (DWG. 7420 D 1)
COINCIDENCE GATE
RESET GENERATOR
DELAY GENERATOR
-40 & -15V SUPPLY
DETAIL "A"
THUMB-WHEEL SWITCH MARKING (SHOWN AT "9" POSITION)
TO DCU TERMINALS
INPUT CHANNEL (DWG. 7000 C-300)
TO K-501 OUTPUT CHANNEL "A" (DWG. 7400 C-3)
TO K-501 OUTPUT CHANNEL "B" (DWG. 7400 C-3)
HEATER CONNECTIONS
NOTE:
1) RESISTORS: WATTAGE — ½ W EXCEPT AS NOTED. TOLERANCE — 10% " " " ".
2) CAPACITORS: CAPACITY — IN μμf EXCEPT AS NOTED.
3) B+ NOMINAL VALUE +220v DC. B- NOMINAL VALUE -110 v DC.
4) NOT USED IN MODEL 7423
5) NOT USED IN MODEL 7423 & 7424.
6) NOT USED IN MODEL 7423, 7424 & 7425.

SWITCHING AND CONTROL CIRCUITS
SCHEMATIC DIAGRAM



NOTE:
1) RESISTORS:
   VOLTAGE ——— ½ W. EXCEPT AS NOTED
   TOLERANCE ——— 10% " "
2) CAPACITORS:
   CAPACITY ——— IN µµf. EXCEPT AS NOTED.
3) B+ NOMINAL +220 VOLTS.
4) B- NOMINAL -110 VOLTS.

Nov. 1959

BECKMAN/BERKELEY DIVISION
DWG. NO. 7420 D 1

PARTS LIST, INPUT CHANNEL

Refer to Dwg. No. 7000C300

ABBREVIATIONS

AB	Allen-Bradley Company, Milwaukee, Wisconsin
BDB	Berkeley Division Beckman, Richmond, California
GE	General Electric, Schenectady, New York
IPC	Industrial Products Co., Danbury, Connecticut
RCA	Radio Corporation of America, Harrison, New Jersey

NOTE

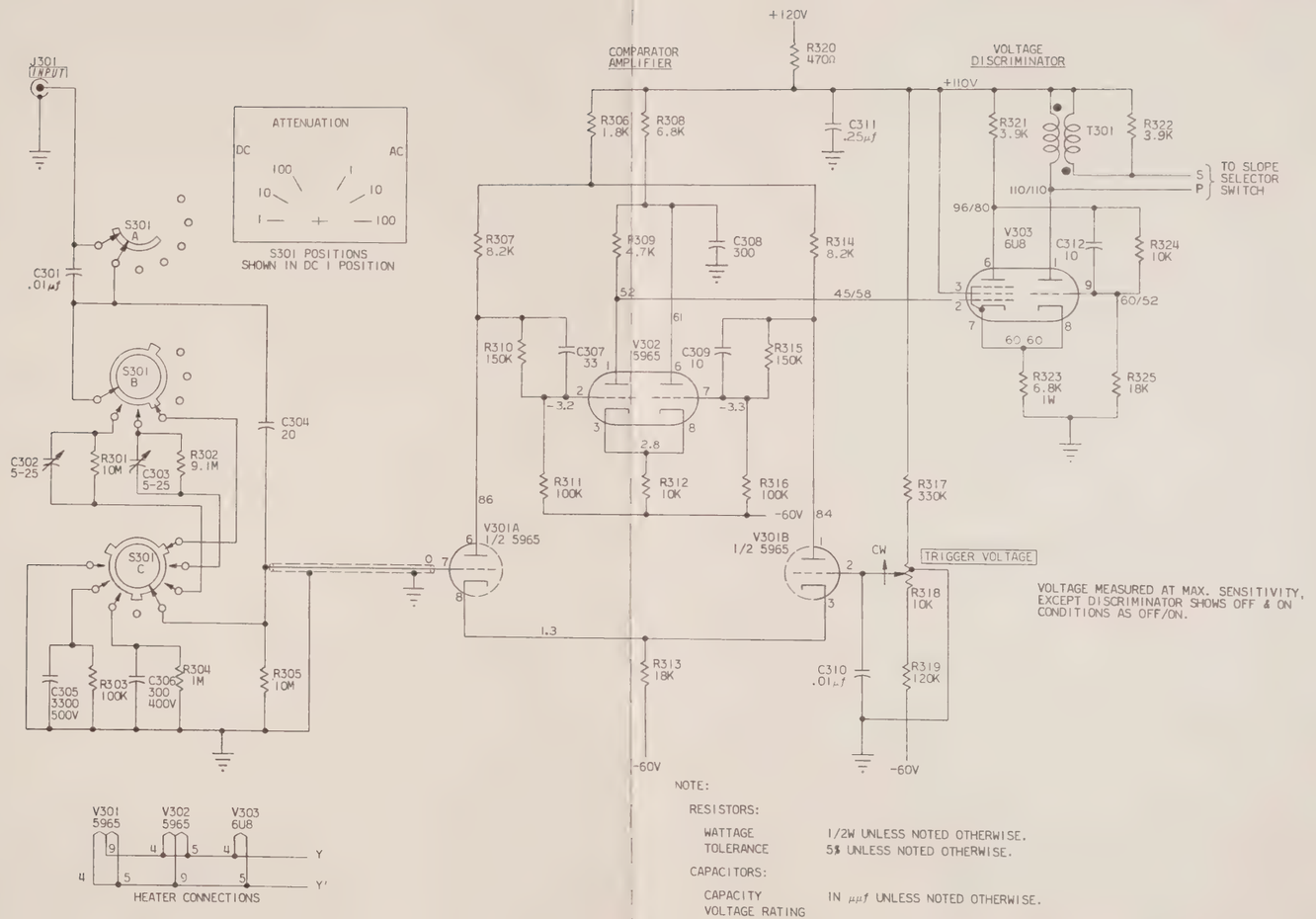
The following parts list includes all electrical components except fixed composition resistors whose value, rating, and tolerance are given on the schematic diagram.

Detail No.	Berkeley Stock No.	Description	Manufacturer & No.
C301	2-2230	Cap., .01 μfd, ceramic disc	Erie 811
C302 & C303	2-2326	Capacitor, 5-25 μμfd, Variable	Erie 557-F
C304	2-1939	Capacitor, 20 μμfd, Mica	Sangamo RR 1420
C305	2-6474	Capacitor, 3300 μμfd, Mica	Sangamo CR 1233
C306	2-2608	Capacitor, 300 μμfd, Mica	Sangamo RR 1330
C307	2-2607	Cap., 33 μμfd, Mica	Sangamo RR 1433
C308	2-2608	Cap., 300 μμfd, Mica	Sangamo RR 1330
C309	2-2082	Cap., 10 μμfd, Mica	Sangamo RR 1410
C310	2-2230	Same as C301	Erie 811
C311	2-5747	Cap., .25 Mfd, 200 V Metalized	Hopkins Eng.
C312		Same as C309	

Detail No.	Berkeley Stock No.	Description	Manufacturer & No.
J301 & J302	17-3179	Connector, Low Voltage	IPC MS 595
R318	1-5573	Potentiometer, 10K, 2W, 2.0% 40% tap.	AB JU1032-SD3048
S301	12-5698	Switch, 2 Sec., 7 Pos.	
T301	6-5821	Transformer, Pulse 300 μ H	BDB
V301 & V302	5-3301	Tube, 5965	RCA
V303	5-2526	Tube, 6U8	GE
XV301, XV302 & XV303	4-2973	Socket, 9 Pin W/O Shield W/ Lugs	Elco 377BC

January 1960

INPUT CHANNEL SCHEMATIC DIAGRAM



VOLTAGE MEASURED AT MAX. SENSITIVITY, EXCEPT DISCRIMINATOR SHOWS OFF & ON CONDITIONS AS OFF/ON.

NOTE:

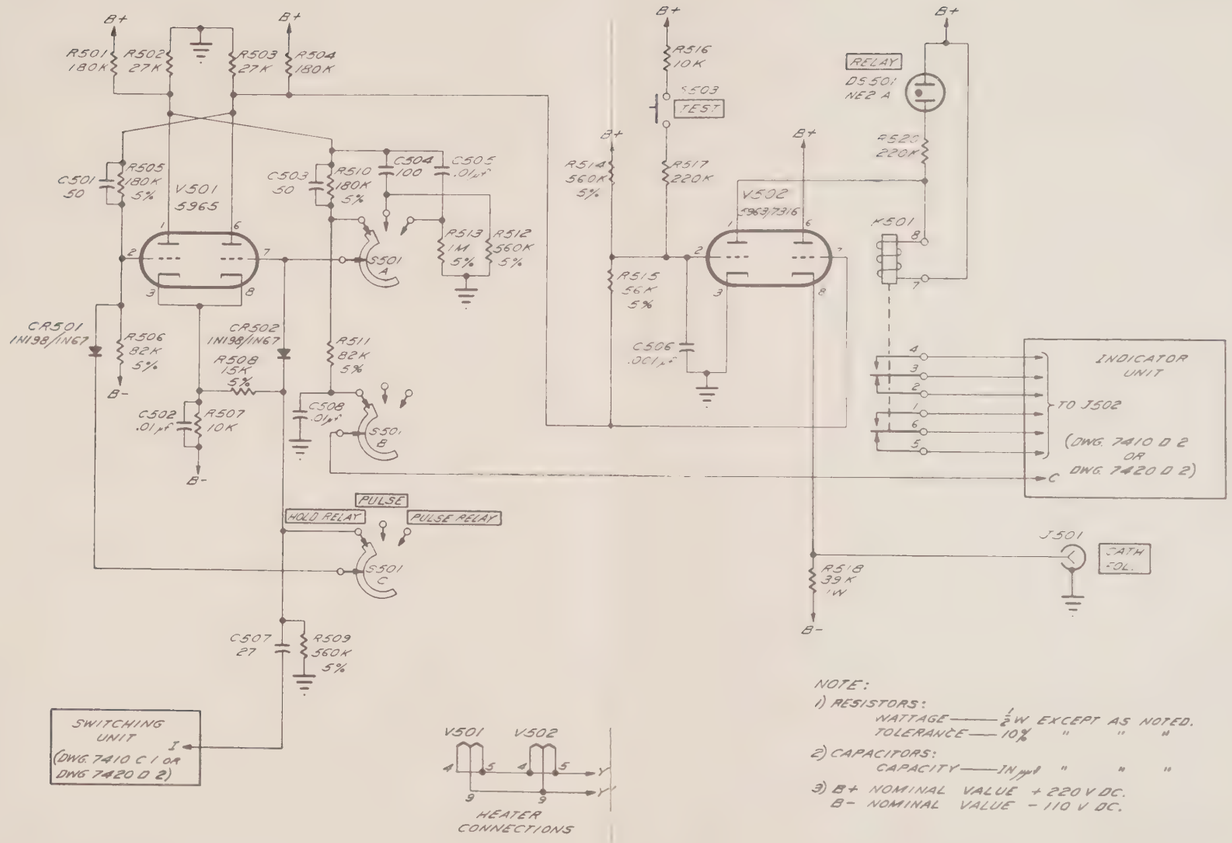
RESISTORS:

WATTAGE 1/2W UNLESS NOTED OTHERWISE.
TOLERANCE 5% UNLESS NOTED OTHERWISE.

CAPACITORS:

CAPACITY IN μμf UNLESS NOTED OTHERWISE.
VOLTAGE RATING

BECKMAN/ BERKELEY DIVISION
DWG. NO. 7000 C 300



NOTE:

1) RESISTORS:
   WATTAGE —— ½ W. EXCEPT AS NOTED.
   TOLERANCE —— 10% " " "
2) CAPACITORS:
   CAPACITY —— IN μμf " " "
3) B+ NOMINAL VALUE + 220 V DC.
   B- NOMINAL VALUE - 110 V DC.

PARTS LIST, POWER SUPPLY

Refer to Dwg. No. 7370 C 100.

ABBREVIATIONS

AB	Allen-Bradley Co., Milwaukee, Wis.
BDB	Berkeley Division Beckman, Richmond, Calif.
CH	Cutler-Hammer Co., Milwaukee, Wis.
DCF	Deposited carbon film
GE	General Electric, Schenectady, N.Y.
Gen. Ind.	General Industries, Elyria, Ohio
VDC	Volts direct current
WW	Wirewound

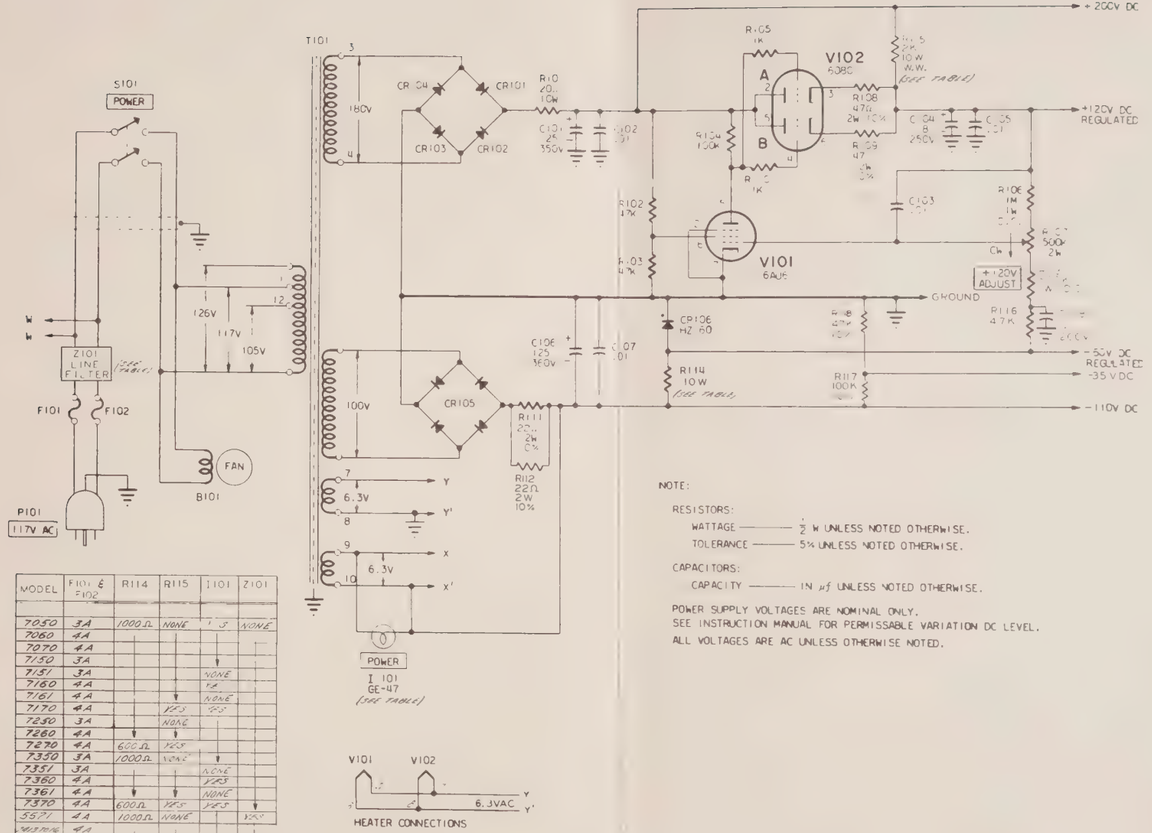
NOTE

Any resistor which does not appear in the list below is a fixed composition resistor of the value, wattage and tolerance noted on the schematic diagram. All other electrical components are listed.

Detail No.	Berkeley Stock No.	Description	Manufacturer & No.
B101	9-3390	Fan Motor	Gen. Ind. A5CW
C101	2-4254	Capacitor, 125μf, 350 v.	Mallory FP140
C102	2-2230	Capacitor, disc, .01μf	Erie Type 811-, 01
C103		Same as C102	
C104	2-3982	Capacitor, electrolytic, 8μf, 250 v.	Sangamo MT 2508
C105		Same as C102	
C106		Same as C101	
C107		Same as C102	
C108	2-5937	Capacitor, 0.1μf, ±20%, 200VDC	Sangamo 330201
CR101	8-4425	Rectifier, silicon	Sarkes Tarzian M500
CR102		Same as CR101	
CR103		Same as CR101	
CR104		Same as CR101	
CR105	8-5633	Rectifier, 110 v rms, 110VDC, 130ma	GE 6R21PB3AT1
CR106	8-7228	Diode	BDB
F101	7-3824	Fuse, SloBlo, 4 amp., 125 v.	Littelfuse 313004 3 AG
F102		Same as F101	
I101	21-1677	Lamp	GE 47
R101	1-2927	Resistor, 20Ω, 10W	Tru-Ohm FRL-10
R106	1-6257	Resistor, DCF, 1 meg., 1W	Arnhold Ceramics Stemag Type A2
R107	1-2905	Potentiometer, Linear Carbon, 500K, 2W	AB JU 5041 SD 3048
R113	1-6258	Resistor, DCF, 500K, 1W	Arnhold Ceramics Stemag Type A2
R114 (All Models except 7270 & 7370)	1-0998	Resistor, WW, 1000Ω, 10W, 10%	Tru-Ohm FRL-10
R114 (Models 7270 & 7370)	1-7267	Resistor, WW, 600Ω, 10W	Tru-Ohm FRL-10
R115	1-1067	Resistor, WW, 2K, 10W	Tru-Ohm FRL-10
S101	12-1642	Switch, toggle, DPST	CH 8370 K8
T101	6-7265	Transformer, power	BDB
V101	5-0550	Tube, 6AU6	
V102	5-2625	Tube, 6080	
XCR101	24-4459	Spring Clip	Littelfuse 099062
XCR102		Same as XCR101	
XCR103		Same as XCR101	
XCR104		Same as XCR101	
XF101	4-3154	Fuse Post	Bussman HKP
XF102		Same as XF101	
XI101	4-1678	Lamp Socket Assy., green jewel	Dialco 81410-132
XV101	4-2972	Tube Socket, 7 pin	Elco 316BC
XV102	4-2377	Tube Socket, octal	Cinch 9950

Dec 1959

POWER SUPPLY SCHEMATIC DIAGRAM



MODEL	F101 & F102	R114	R115	I101	Z101
7050	3A	1000Ω	NONE	1 3	NONE
7060	4A				
7070	4A				
7150	3A				
7151	3A			NONE	
7160	4A			1A	
7161	4A			NONE	
7170	4A		YES	YES	
7230	3A		NONE		
7280	4A				
7270	4A	600Ω	YES		
7350	3A	1000Ω	NONE		
7351	3A			NONE	
7360	4A			YES	
7361	4A			NONE	
7370	4A	600Ω	YES	YES	
5571	4A	1000Ω	NONE		YES
[illegible]	4A				
[illegible]	4A				
[illegible]	3A			NONE	NONE

NOTE:

RESISTORS:
WATTAGE ——— ½ W UNLESS NOTED OTHERWISE.
TOLERANCE ——— 5% UNLESS NOTED OTHERWISE.

CAPACITORS:
CAPACITY ——— IN μf UNLESS NOTED OTHERWISE.

POWER SUPPLY VOLTAGES ARE NOMINAL ONLY.
SEE INSTRUCTION MANUAL FOR PERMISSABLE VARIATION DC LEVEL.
ALL VOLTAGES ARE AC UNLESS OTHERWISE NOTED.

INSTRUCTION MANUAL

Models 705AH, 705AJ & 705AK
DECIMAL COUNTING UNITS

Lot No.

BERKELEY division
Beckman Instruments, Inc.

Richmond 4, California
18 March 1957

WARRANTY

Instruments sold by Berkeley Division, Beckman Instruments, Inc., (hereafter called "the Company") are warranted only as stated below.

Subject to the exceptions and upon the conditions specified below, the Company agrees to correct, either by repair, or, at its election, by replacement, any defect of material or workmanship which develops within one year after delivery of the instrument to the original purchaser by the Company or by an authorized representative, provided that investigation and factory inspection by the Company discloses that such defect developed under normal and proper use.

The exceptions and conditions mentioned above are the following:

(a) Some components and accessories by their nature are not intended to, and will not, function one year. If any such component or accessory manufactured by the Company and part of the item sold fails to give reasonable service for a reasonable period of time, the Company will, at its election, replace or repair such component or accessory. What constitutes reasonable service and what constitutes a reasonable period of time shall be determined solely by the Company after the Company is in posession of all the facts concerning operating conditions and other pertinent factors and after such component or accessory has been returned to the Company, transportation prepaid.

(b) All instruments claimed defective must be returned to the Company, transportation charges prepaid, and will be returned to the customer with the transportation charges collect, unless the item is found to be defective in which case the Company will pay all transportation charges.

(c) The Company makes no warranty concerning components or accessories not manufactured by it, such as tubes, fuses, batteries, etc. However, in the event of the failure of any component or accessory not manufactured by the Company, the Company will give reasonable assistance to the purchaser in obtaining from the respective manufacturer whatever adjustment is reasonable in the light of the manufacturer's own warranty.

(d) Except as stated above, the Company makes no warranty, express or implied (either in fact or by operation of law), statutory or otherwise; and, except to the extent stated above, the Company shall have no liability under any warranty, express or implied (either in fact or by operation of law), statutory or otherwise.

(e) The Company expressly disclaims any liability to its customers, dealers, and to users of its products, and to any other person or persons for consequential damages of any kind and from any cause whatsoever arising out of or in any way connected with the manufacture, sale, repair, replacement of, or arising out of or in any way connected with the use of any of its products.

(f) Representations and warranties made by any person, including representatives of the Company, which are inconsistent or in conflict with the terms of this warranty (including but not limited to the limitation of the liability of the Company as set forth above) shall not be binding upon the Company unless reduced to writing and approved by an officer of the Company.

(g) This warranty shall be governed by the laws of the State of California.

Claims for damage in shipment should be filed promptly with the transportation company.

All correspondence concerning the instrument should specify the model and serial number. This information appears on the company name plate. Any inquiry concerning details of operation, possible modifications, etc., should be addressed to the Sales Department, Berkeley division of Beckman Instruments, Inc., Richmond 4, California.

REPAIR SERVICE

Experienced service personnel and special test equipment are available at the factory to perform any necessary repairs. Every effort will be made to expedite the repair of instruments returned for servicing. Repair work will be performed only upon receipt of a written purchase order or authorization. Instruments to be repaired should be addressed to SERVICE AND REPAIR DEPARTMENT with transportation charges prepaid. Repaired instruments will be returned to the purchaser with transportation charges collect.

Berkeley reserves the right to make changes in design at any time without incurring any obligation to modify equipment previously purchased to conform to subsequent design changes.

BERKELEY DIVISION
BECKMAN INSTRUMENTS, INC.

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PLEASE NOTE

Some tube types in this unit may not correspond to those shown on the schematic diagram. Type 7316 is equivalent to 5963, and type 7119 is equivalent to 5687.

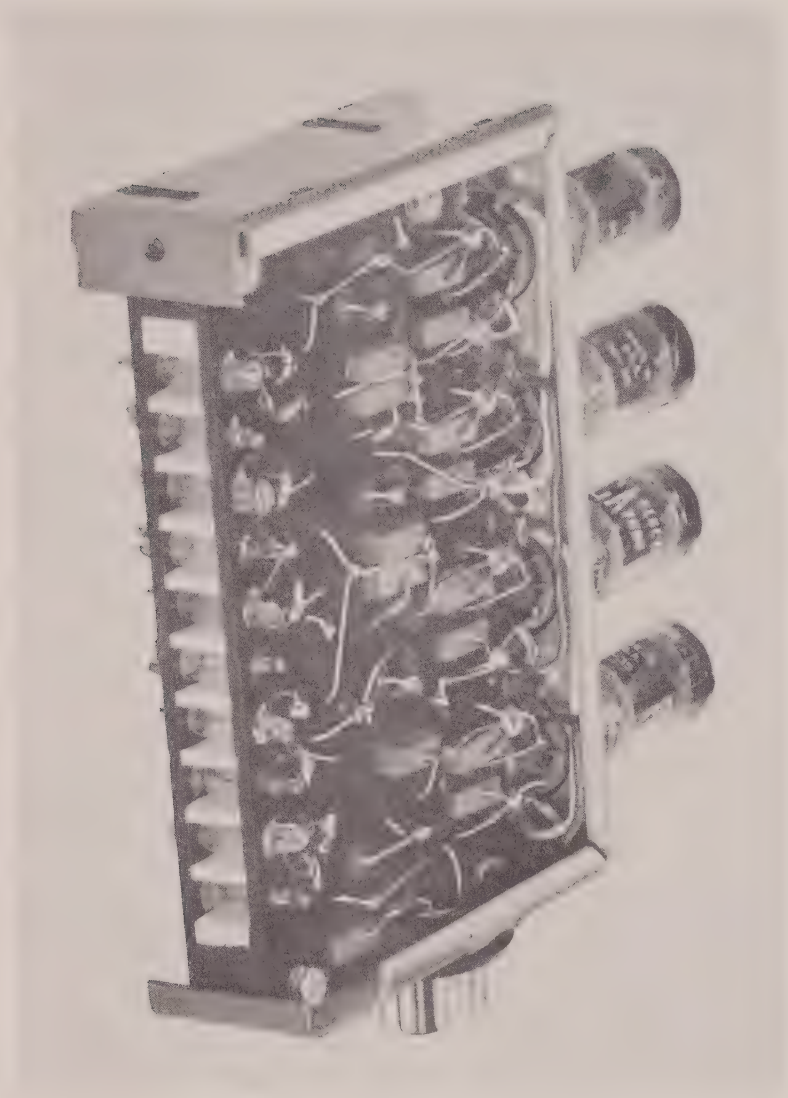
INSTRUCTION MANUAL REVISION

Models affected:

705A	705AJ
705AE	705AK
705AEFM	705AL
705AF	705ALJ
705AFM	705AP
705AG	705AP/1
705AH	705AW
705AHJ	705AZ
705AHP	705AZS
705AHP/1	705B
705AHZ	

Please make the following change in the manual where applicable:

Change the value of capacitor C117 from 50$\mu\mu$f to 68$\mu\mu$f.



Model 705AH Decimal Counting Unit with side covers and indicating panel removed.

CONTENTS

	Page
Introduction	1
Specifications	1
Operation	1
Power Requirements	1
Input Requirements	1
Output Characteristics	1
Method of Resetting after a Counting Period	2
Binary Coded Readout	2
Extinquishing the Indicating Lamps	2
Circuit Description	2
The Binaries	2
The Scale-of-Ten	3
Troubleshooting Procedures	5
Troubleshooting Chart	5
Table of Voltages and Resistances	7
Typical Waveforms	8
Parts Location	10
Schematic Diagram, Model 705AH	11
Schematic Diagram, Model 705AJ	12
Schematic Diagram, Model 705AK	13
Mounting Dimensions	14

ILLUSTRATIONS

		Page
Model 705AH		Frontispiece
Figure 1.	A Typical Binary	3
Figure 2.	Block Diagram	3
Figure 3.	Idealized Waveforms	4
Figure 4.	Blanked Waveforms At Input Frequency of 20KC	8
Figure 5.	Blanked Waveforms At Input Frequency of 100KC	9
Figure 6.	Parts Location	10

INTRODUCTION

These decimal counting units are direct-reading, plug-in electronic counters. The number of input pulses received is indicated by the illumination of one of ten neon lamps placed behind a numbered acetate panel. Each unit counts from zero to nine, the tenth pulse resetting the counter to zero and simultaneously generating an output signal. Any number of these units can be connected in cascade (the output of one unit driving the next) forming a counter whose total count capacity depends only on the number of DCU's. Thus, five units will count to 99, 999 resetting to "00, 000" on the 100, 000th pulse.

Models 705AH and 705AK generate a binary coded decimal readout. This code is in the form of high or low voltages at each of four pins on the DCU plug.

SPECIFICATIONS

Count Indication

Direct reading, decimal presentation

Power Requirements

Heaters: 6.3 v. at 1.2 amps

Plates: 300 v. at 13 ma

Input Requirements

Negative pulses (See "OPERATION")

Output Characteristics

Designed to drive a Model 705A DCU or any modification thereof (i.e., 705AH, 705AK, etc.)

Resolution of Paired Pulses

5 microseconds

Reset

Will reset to either zero or nine depending on polarity of reset pulse applied.

Maximum Counting Rate

100, 000 counts per second

Construction

Plug-in unit, 11-pin socket

OPERATION

Power Requirements. The heaters require 6.3 volts ac at 1.2 amperes. The plate circuits may be operated on from 200 to 400 volts, although the design center is 300 volts at 13 ma. Plate voltage may be applied in the form of B + and B - voltages. The d-c level of all output voltages will depend upon the level of the plate supply voltages.

Input Requirements. A negative pulse at least two microseconds wide is required to drive the unit. The optimum pulse amplitude depends on the rise time. With a rise time of 0.5 microseconds (measured between ten and ninety percent values) the pulse amplitude should be between 75 and 135 volts. With a two-microsecond rise time, the amplitude should be between 120 and 165 volts. When operating the plate circuits on 300 volts, optimum performance is obtained with a rise time of one microsecond or less and a pulse amplitude of 100 volts. If the unit is powered by unregulated d-c supplies, the input pulse amplitude should vary in phase with the supply voltage. The input load presented when an input pulse occurs is 15K ohms in series with 100 micromicrofarads.

Output Characteristics. The output is the rectangular waveform shown in Figure 3. As every tenth input pulse triggers the unit from count display "9" to count display "0", a negative transient occurs at pin 4 of the DCU plug. With a plate supply of 300 volts, the potential at pin 4 drops from + 135 to + 55 volts with respect to B-. This transient can be used to drive succeeding decimal counting units or other circuitry. The load impedance connected

between the output terminal and ground must not be less than 300K or 6K in series with 100 micro-microfarads.

Method of Resetting after a Counting Period. A DCU can be reset to a registered count of either zero or nine by the application of a voltage pulse of the proper polarity to the proper pin of the DCU plug. See the table below.

	RESET TO ZERO		RESET TO NINE	
	Pulse Polarity	Applied at Pin No.	Pulse Polarity	Applied at Pin No.
705AH	Neg.	8	Pos.	8
705AJ	Neg.	8	Pos.	8
	Pos.	3	Neg.	3
705AK	Neg.	8	Pos.	8

The reset pin (or pins in the base of Model 705AJ) should be maintained at the B- supply voltage except when a reset pulse occurs. A 50-volt pulse at least 3μseconds wide is adequate. A 100-volt pulse need be only 1.5μseconds wide. There is no maximum pulse width; however the DCU will not begin counting again until the reset pin returns to the B- supply voltage.

Simply disconnecting a reset pin from B- with a switch or relay will have the same effect as applying a positive pulse.

Binary Code Readout. Models 705AH and 705AK generate a modified binary code representing the decimal digit registered. The code appears in the form of a voltage (high or low) at one plate of each of four double-triode binaries. In the table below, "0" represents a plate voltage of approximately +55 volts with respect to B-; "1" represents a plate voltage of about +135 volts with respect to B-. (These are the voltage levels which appear when using a 300-volt plate supply.) Each of the four plates is coupled to a pin of the DCU plug through a 1.2 megohm resistor except in the case of pin 4 on the 705AK DCU. This pin is connected directly to a plate of the fourth binary. To obtain a readout voltage at this pin, it is necessary to add a 1.2M resistor externally.

DECIMAL DIGIT REGISTERED	FOUR - LINE BINARY CODE			
	1st Binary Stage (Pin 2 of DCU plug)	2nd Binary Stage (pin 6 of DCU plug)	3rd Binary Stage (Pin 9 of DCU plug)	4th Binary (Pin 10, 705AH) (Pin 4, 705AK)
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	1	1	0
5	1	1	1	0
6	0	0	1	1
7	1	0	1	1
8	0	1	1	1
9	1	1	1	1

Extinguishing the Indicating Lamps During the Counting Period. On Models 705AJ and 705AK, it is possible to prevent the neon bulbs from lighting by placing approximately -100 volts with respect to B- on pin 10 of the DCU plug. Ordinarily, the user will wish to extinguish the bulb while the DCU is actively counting, and to allow them to light, indicating the registered count at the end of a counting period.

CIRCUIT DESCRIPTION

The Binaries. The decimal counting units contain four "flip-flop" circuits. These circuits are slightly modified versions of the Eccles-Jordan trigger circuit. They are referred to here as binaries.

Figure 1 is a schematic diagram of a typical binary. It consists of two triode voltage amplifiers with the plate of each direct-coupled to the grid of the other. With no input this circuit assumes one of two stable states: V1 conducting steadily and V2 cut

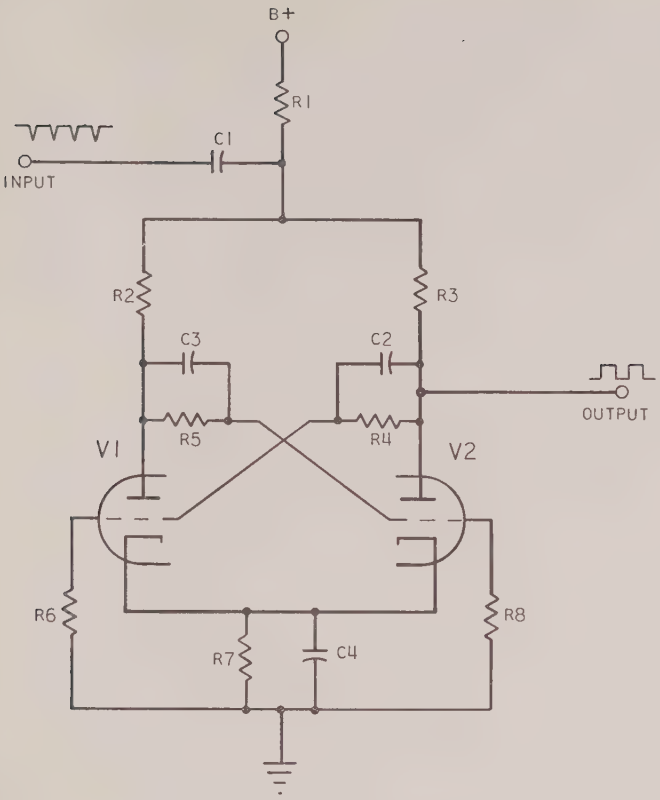


FIGURE 1. A TYPICAL BINARY.

off, or V2 conducting and V1 cut off. Suppose V1 is not conducting. Then, its plate is near the B- voltage. A portion of this voltage, applied to the grid of V2 through the voltage dividing network R5 and R8, raises this grid above cut-off and permits V2 to conduct. While V2 is conducting, the low positive potential at its plate, coupled to the grid of V1 through the dividing network R4 and R6, holds this grid several volts below cut-off. Since small changes in the potential at the grid of V1 will not raise it above cut-off, this state is stable and will persist until disturbed by an appreciable input signal. Notice that, since the circuit is symmetrical, the opposite state is equally stable.

The circuit is triggered from one state to another by negative pulses applied at the input. For example, assume that V2 is conducting and V1 is cut off. If a negative pulse is applied to the input, there is a drop in the plate voltage of V1. This drop in voltage is transmitted through a crossover network (R5, R8, C3 and the grid-to-ground capacitance of V2) and applied to the grid of V2. The plate voltage of V2 then starts to rise, carrying with it the grid of V1. If the input pulse is of sufficient amplitude, V1 begins to conduct. The moment V1 conducts, the drop in voltage at its plate, coupled to the grid of V1, reinforces the negative transient there. This regenerative action proceeds rapidly until V2 is cut off and V1 is conducting at a steady rate. The next adequate input transient causes a reverse action and returns the binary to its original state. Thus, the binary completes a cycle for every two input transients applied, making it a scale-of-two. The output is the drop in voltage at one of the plates as that triode begins to conduct. This output, consisting of one negative transient for every two input transients, is suitable for driving another binary. By connecting binaries in cascade (output of one to input of the next) a counter having a scale of any power of two can be built.

The Scale of Ten. In the Model 705A four binaries are connected in cascade forming a scale-of-16 which is permuted to a scale-of-10 by two positive feedback paths. (See Figures 2 and 3). For the first three negative input pulses, the unit operates like a simple binary counter. At the fourth input pulse, the third binary is triggered for the first time, sending a pulse through the first feedback path which triggers the second binary. Since it requires two input pulses to trigger the second binary, this is equivalent to adding two input pulses; therefore, the state of the unit now

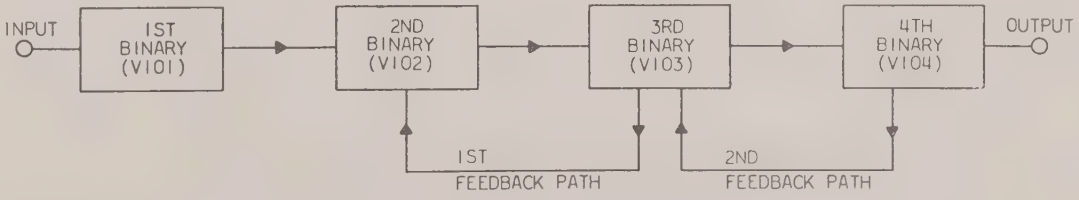


FIGURE 2. BLOCK DIAGRAM.

corresponds to a binary count of six. The sixth input pulse (equivalent to the eight in a simple binary chain) triggers the fourth binary which sends a pulse through the second feedback path, triggering the third binary. This is equivalent to adding four more input pulses so the state of the unit now corresponds to a binary count of 12. For the next four input pulses (7 thru 10) the unit operates again as a simple binary chain, producing an output pulse at the tenth input pulse. Adding the equivalent of six input pulses internally has changed the binary chain from a scale-of-16 to a scale-of-10.

When the third binary is triggered by a feedback pulse, it tends to retrigger the second binary in the same way that it did at the time of input pulse four. This tendency is offset by a simultaneous opposing signal from the fourth binary.

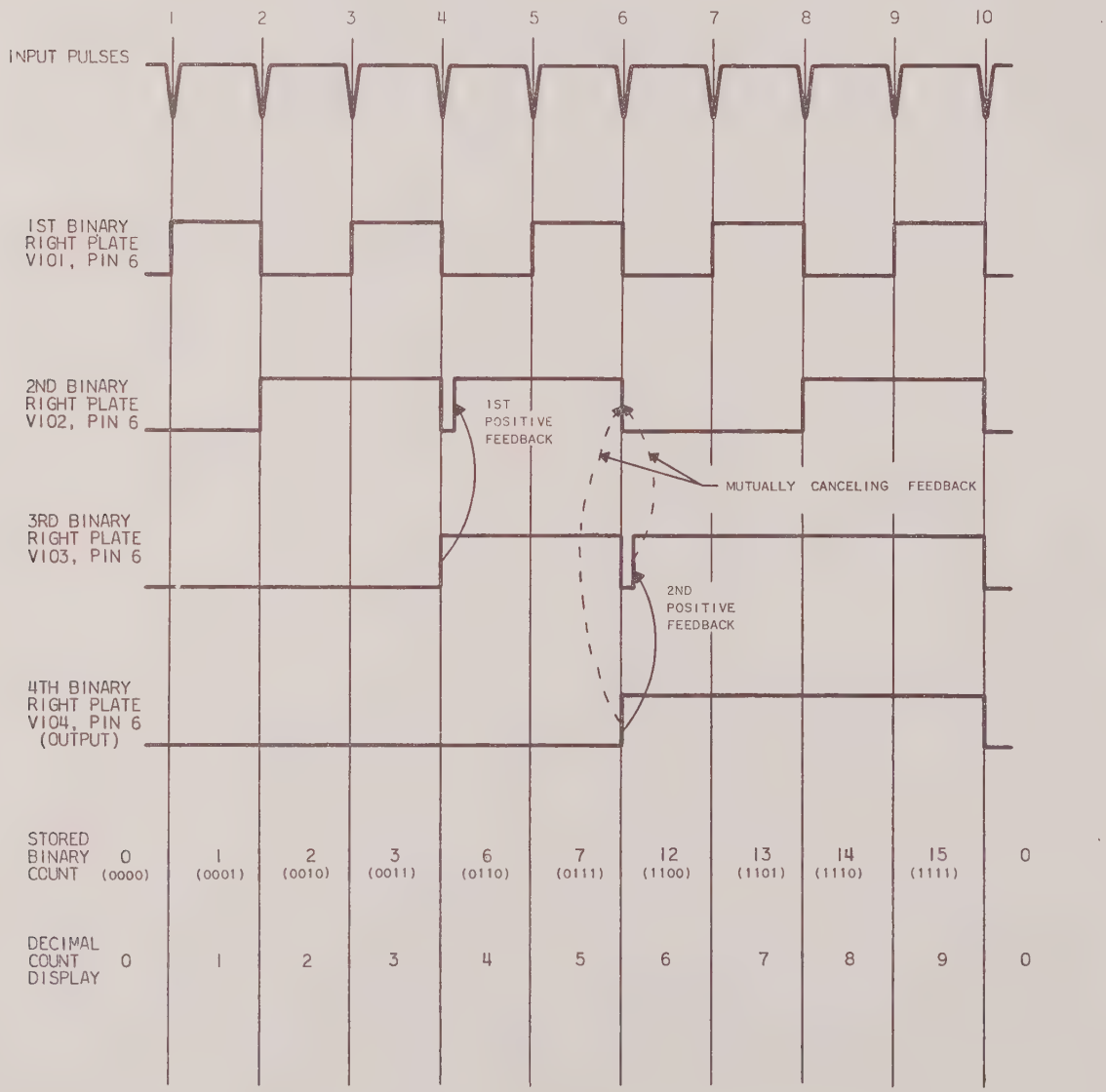


FIGURE 3. IDEALIZED WAVEFORMS. "RIGHT PLATE" REFERS TO THE PLATE APPEARING ON THE RIGHT-HAND SIDE OF THE BINARY AS DRAWN ON THE SCHEMATIC.

TROUBLESHOOTING PROCEDURES

When a decimal counting unit is suspected of counting incorrectly, it should be interchanged with another unit in the instrument or replaced with a spare unit to determine whether the trouble is in the suspected unit or in the associated circuitry. This test should be made very carefully. Because the counting unit is usually the indicating device of an instrument, it is often accused of operating incorrectly when the fault is external to it.

Two methods are recommended for locating a defect in a DCU. The first is to observe the lighting sequence while driving the unit at a slow pulse rate. The second is to study the output waveform of each binary while driving the unit fast enough to create an oscilloscope display. It is impossible to say which method should be used in every case, since marginal failures may occur at high counting speeds and not at lower counting rates, and vice versa. The first method is the only way that a neon lamp failure can be located, and it can be used to locate component and tube failures. For this reason, it is recommended that this method be used first. The table of common troubles lists the probable defects indicated by particular variations from the proper lighting sequence. Binary output waveforms may be compared with the idealized waveforms of Figure 3 and the photographs appearing in Figure 4 & 5.

A table of typical voltages and resistances has been provided to help the serviceman locate a defect within one of the binary stages. Values may deviate considerably from those given without causing trouble. The fact that the unit is designed to operate at plate supply voltages ranging from 200 to 400 volts is a rough indication of permissable tolerances.

TROUBLESHOOTING CHART

NOTE: Reset unit to zero before testing for symptoms

SYMPTOMS	POSSIBLE CAUSES
Unit Fails to Count	(a) Insufficient supply voltage. (b) Input signal of insufficient amplitude (c) Input signal of wrong polarity. (d) First stage inoperative.
Unit Counts Spuriously	(a) Extraneous input signals. (b) Pulses received through power supply. (c) External voltages picked up by output lead.
Units Counts Erratically	(a) Input signal too large or small, incorrect rise time. (b) Supply voltage fluctuating too much.
Unit Fails to Reset	(a) Stray counts from reset switch or associated circuitry. (b) Defective component.

Units counts regularly but neon bulbs light in wrong sequence and the pattern of lighting is repeated consistently after a definite number of input pulses. One or more bulbs may be lit simultaneously during a cycle but the number of states per cycle remains constant.

1. Units skips every other number	(a) First stage defective. (b) Input circuit supplies double pulses.
2. Two stable states per cycle.	(a) Second stage defective (Display sequence may be 01 or 45). (b) Loss of drive to second stage (01).
3. Four stable states per cycle.	(a) Third stage defective (Display sequence may be 0123 or 6789). (b) Loss of drive to third stage (0123).
4. Six stable states per cycle.	(a) Output excessively loaded (Display sequence may be 012345). (b) Last stage inoperative (Display sequence may be 012345 or $67^{89}_{23}89$*). (c) Loss of drive to fourth stage (Display sequence may be 012345).
5. Eight stable states per cycle or any failure where two successive numbers are skipped.	(a) Second or third stage failure.
6. Ten stable states per cycle, but the lighting sequence is incorrect.	(a) When the wrong neon lamp lights, the trouble is usually a defect in the lamp that should have lit, but it may be a defect in the lamp that lit improperly. It's also possible that more than one lamp will light in place of the correct one.
7. Twelve stable states per cycle.	(a) When lighting sequence is $0123^{01}_{45}456789$* the cause may be a failure of the first feedback or lowered cathode emission in first or second binary. (b) When the lighting sequence is $01234567^{23}_{89}89$ the cause may be failure of the second feedback or low cathode emission in third or fourth binary.

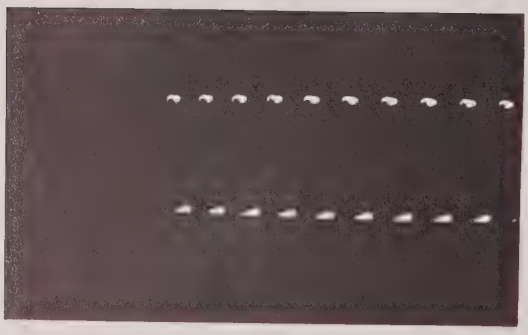
* One digit above another means both lamps are lit.

TABLE OF VOLTAGES & RESISTANCES

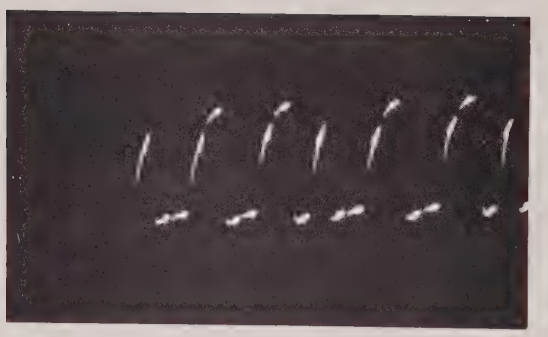
Tube	Pin No.	D-C Voltage with respect to B-.*	Resistance to B minus Terminal**
V101	1	170	105K
	2	17	85K
	3, 8	37	12K
	4, 5, 9	Filaments	
	6	60	105K
	7	37	85K
V102	1	135	93K
	2	15	83K
	3, 8	30	12K
	4, 5, 9	Filaments	
	6	55	93K
	7	30	83K
V103	1	135	100K
	2	15	83K
	3, 8	30	12K
	4, 5, 9	Filaments	
	6	55	100K
	7	30	83K
V104	1	135	93K
	2	15	83K
	3, 8	30	12K
	4, 5, 9	Filaments	
	6	55	93K
	7	30	83K

* Voltages measured in unit with 300-volt plate supply

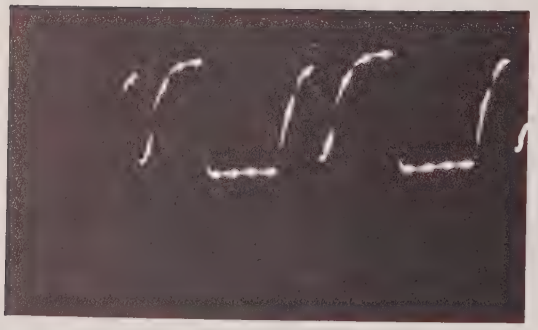
** Before making resistance measurements jumper pins 3 and 8 on the DCU plug.



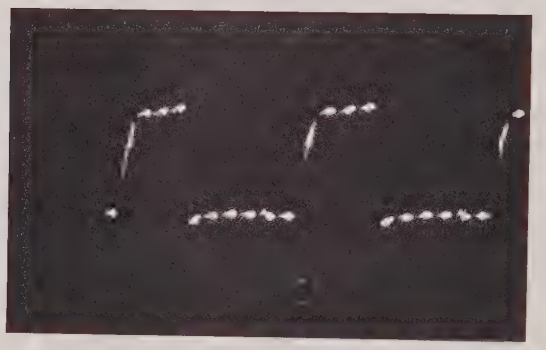
(1) First Binary Output (V101, Pin 6).
Upper voltage level is +168v
Lower voltage level is +55v



(2) Second Binary Output (V102, Pin 6)
Upper voltage level is +140v
Lower voltage level is +55v.

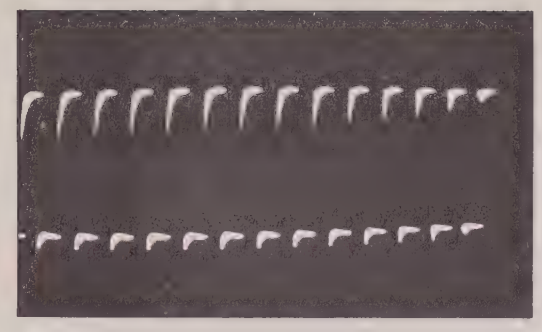


(3) Third Binary Output (V103, Pin 6)
Upper voltage level is +140v.
Lower voltage level is +55v.



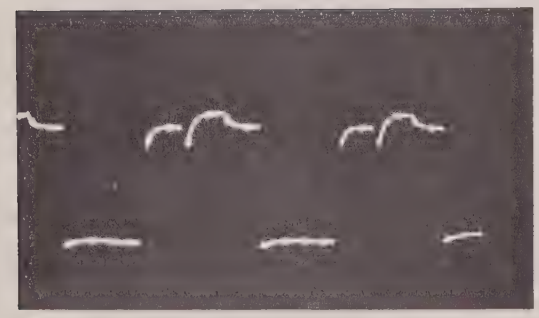
(4) Fourth Binary Output (V104, Pin 6).
Upper voltage level is +140v.
Lower voltage level is +55v.

FIGURE 4. BLANKED WAVEFORMS AT INPUT FREQUENCY OF 20KC. ALL VOLTAGE LEVELS ARE MEASURED WITH RESPECT TO B MINUS.

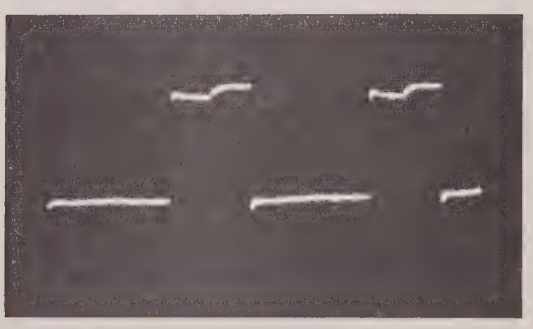


(1) First Binary Output (V101, Pin 6).
Upper Voltage level is +168V
Lower voltage level is +55v

(2) Second Binary Output (V102, Pin 6)
Upper voltage level is +140v
Lower voltage level is +55v.



(3) Third Binary Output (V103, Pin 6)
Upper voltage level is +140v.
Lower voltage level is +55v



(4) Fourth Binary Output (V104, Pin 6).
Upper voltage level is +140v.
Lower voltage level is +55v.

FIGURE 5. BLANKED WAVEFORMS AT INPUT FREQUENCY OF 100KC. ALL VOLTAGE LEVELS ARE MEASURED WITH RESPECT TO B MINUS.

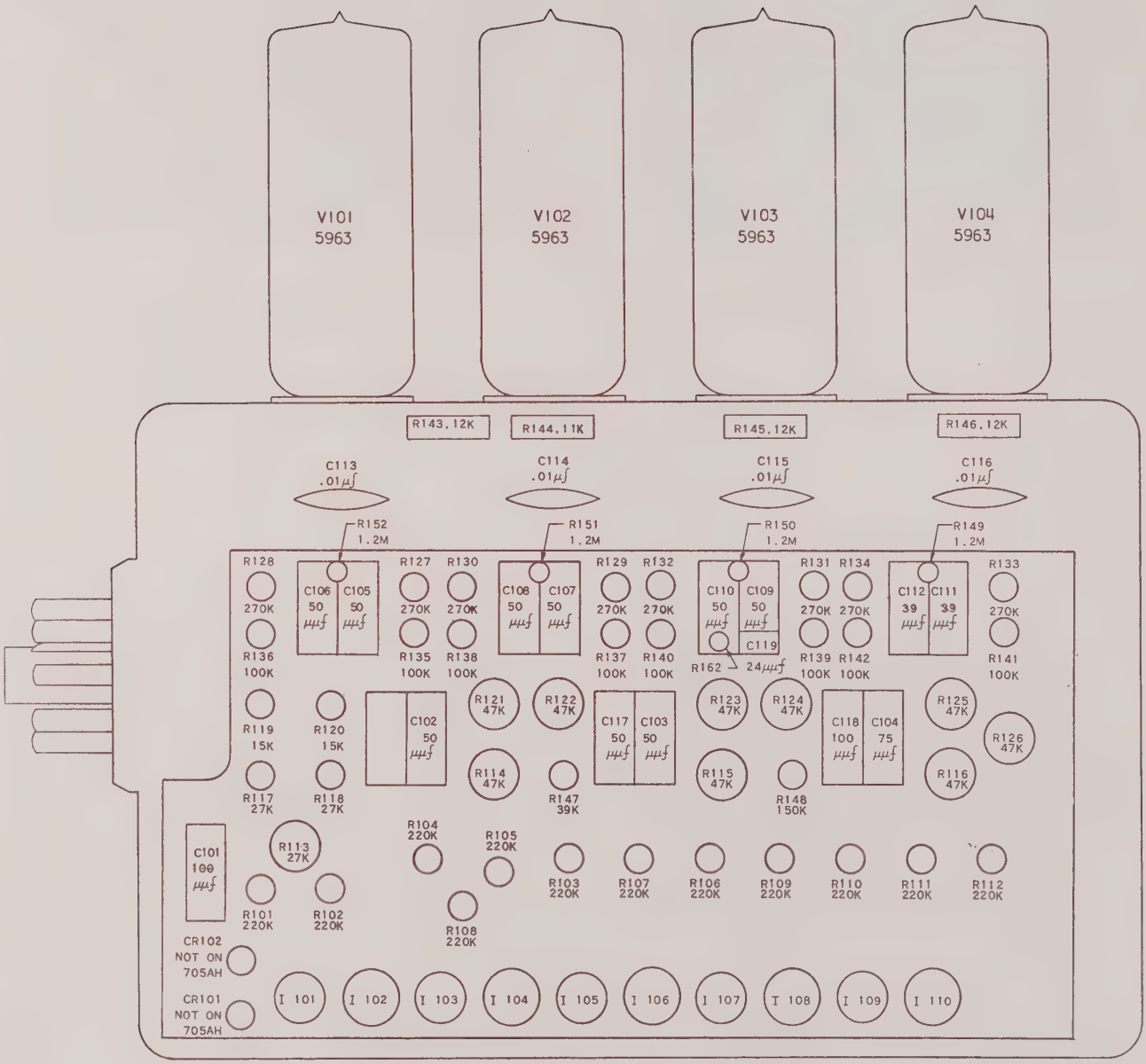
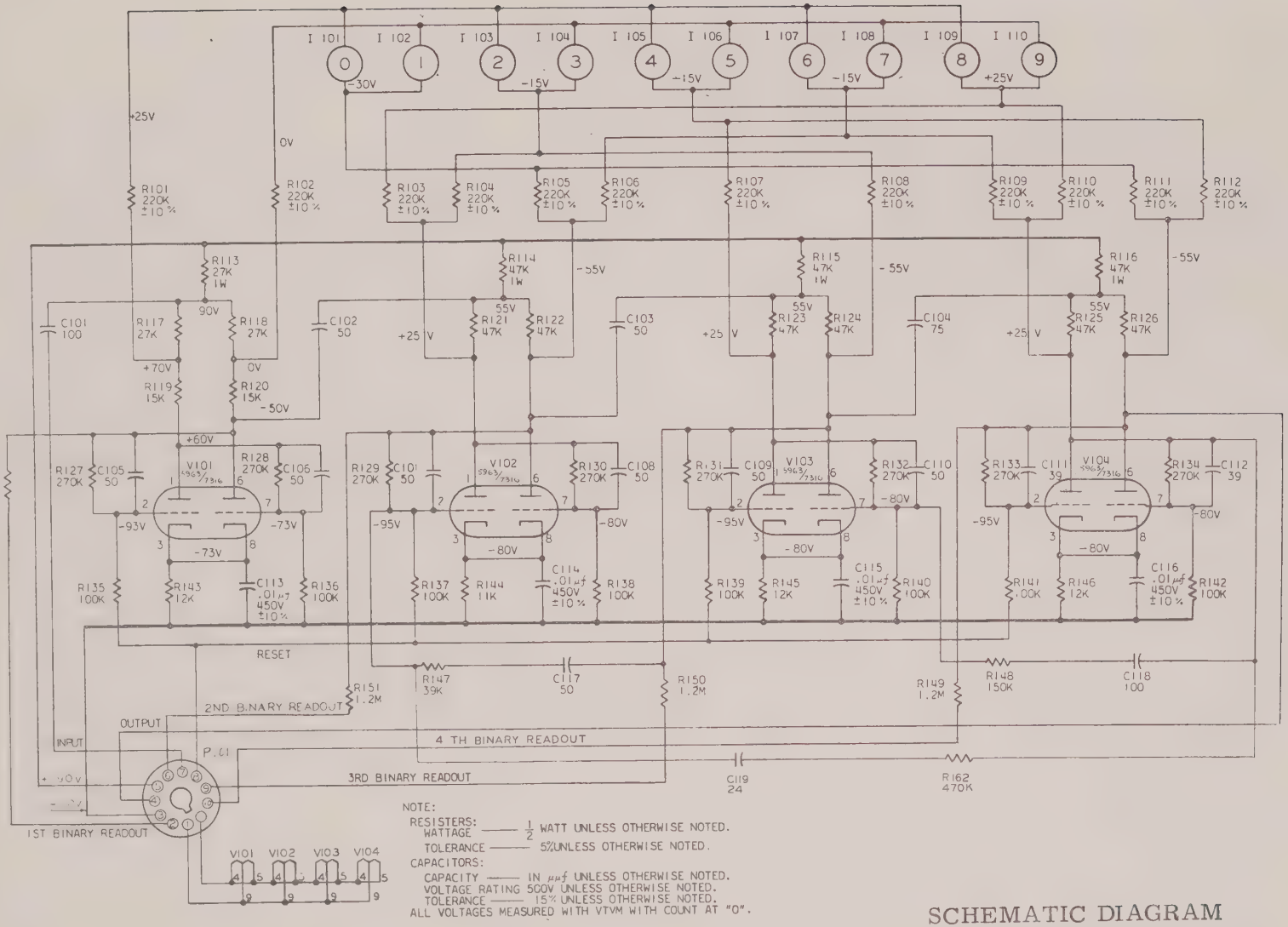
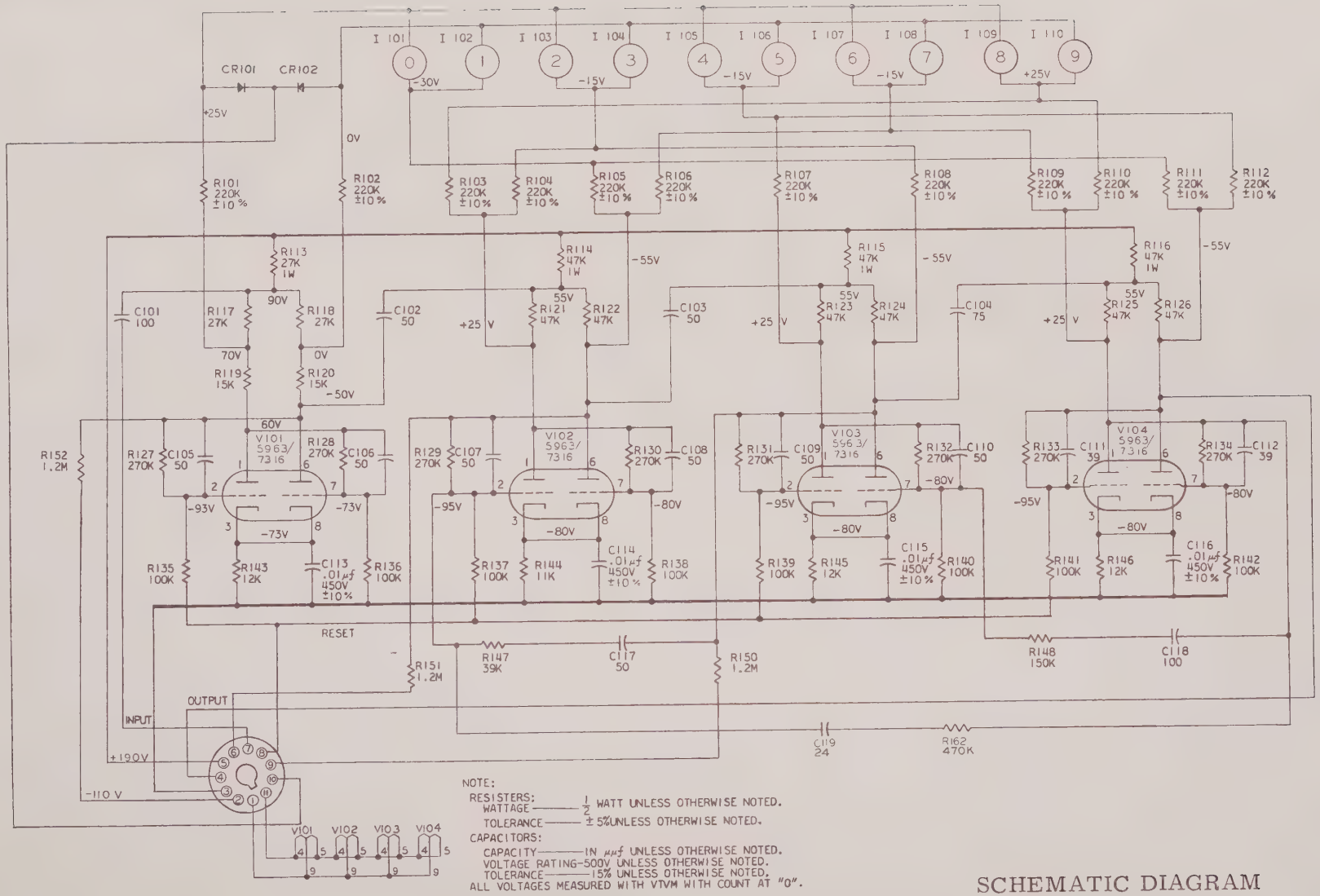


FIGURE 6. PARTS LOCATION

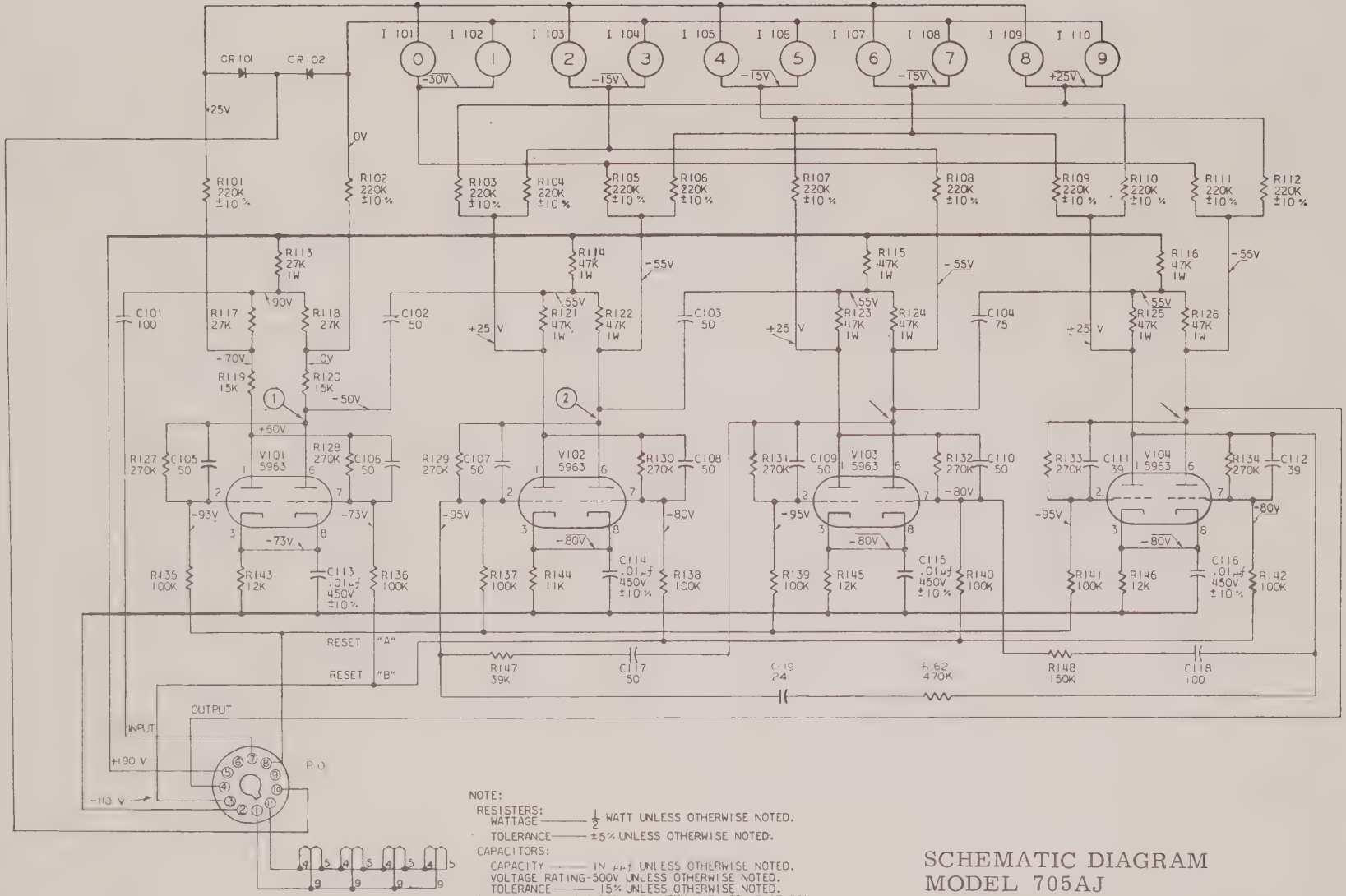


SCHEMATIC DIAGRAM
MODEL 705AH
DECIMAL COUNTING UNIT



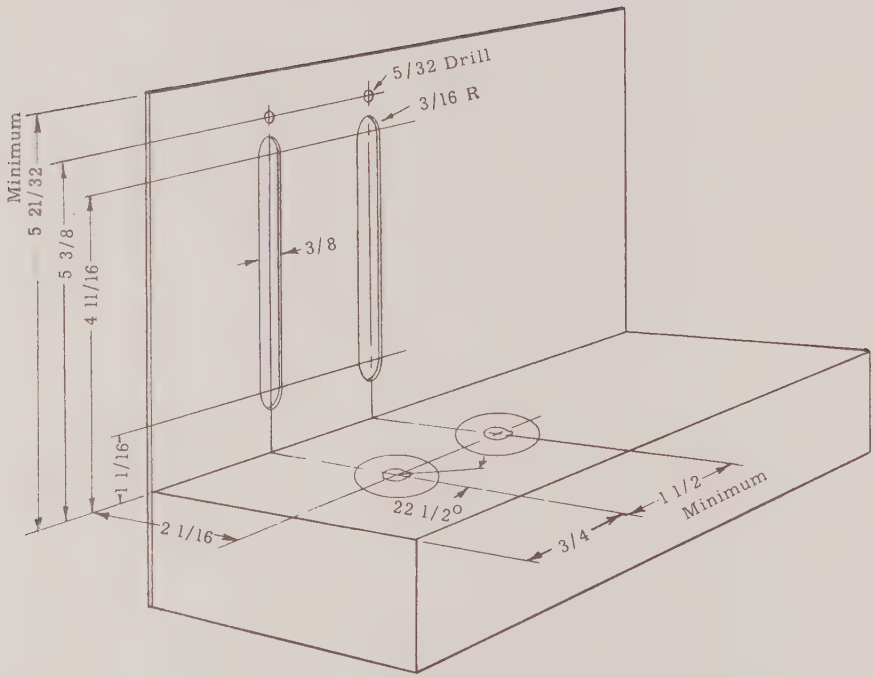
NOTE:
RESISTERS:
WATTAGE——$\frac{1}{2}$ WATT UNLESS OTHERWISE NOTED.
TOLERANCE——±5%UNLESS OTHERWISE NOTED.
CAPACITORS:
CAPACITY——IN μμf UNLESS OTHERWISE NOTED.
VOLTAGE RATING-500V UNLESS OTHERWISE NOTED.
TOLERANCE——15% UNLESS OTHERWISE NOTED.
ALL VOLTAGES MEASURED WITH VTVM WITH COUNT AT "0".

SCHEMATIC DIAGRAM
MODEL 705AK
DECIMAL COUNTING UNIT



NOTE:
RESISTERS:
WATTAGE ——— $\frac{1}{2}$ WATT UNLESS OTHERWISE NOTED.
TOLERANCE ——— ±5% UNLESS OTHERWISE NOTED.
CAPACITORS:
CAPACITY ——— IN μμf UNLESS OTHERWISE NOTED.
VOLTAGE RATING-500V UNLESS OTHERWISE NOTED.
TOLERANCE ——— 15% UNLESS OTHERWISE NOTED.
ALL VOLTAGES MEASURED WITH VTVM WITH COUNT AT "0".
AND PIN #10 DISCONNECTED.

SCHEMATIC DIAGRAM
MODEL 705AJ
DECIMAL COUNTING UNIT



NOTE: Dimensions are based on the use of an Amphenol "MIP" 8 or 11-pin socket mounted above the chassis.

The drawing shows chassis dimensions for mounting two Model 705A DCU's side by side. All modifications of the Model 705A (705AH, 705AF, etc.) have precisely the same dimensions as the standard 705A.

Mounting Dimensions, Model 705A and All Modifications Thereof

INSTRUCTION MANUAL

MODEL 705AHP
DECIMAL COUNTING UNIT

Beckman/ Berkeley Division
Richmond 3, California

November 1959

DECIMAL COUNTING UNIT

MODEL 705AHP

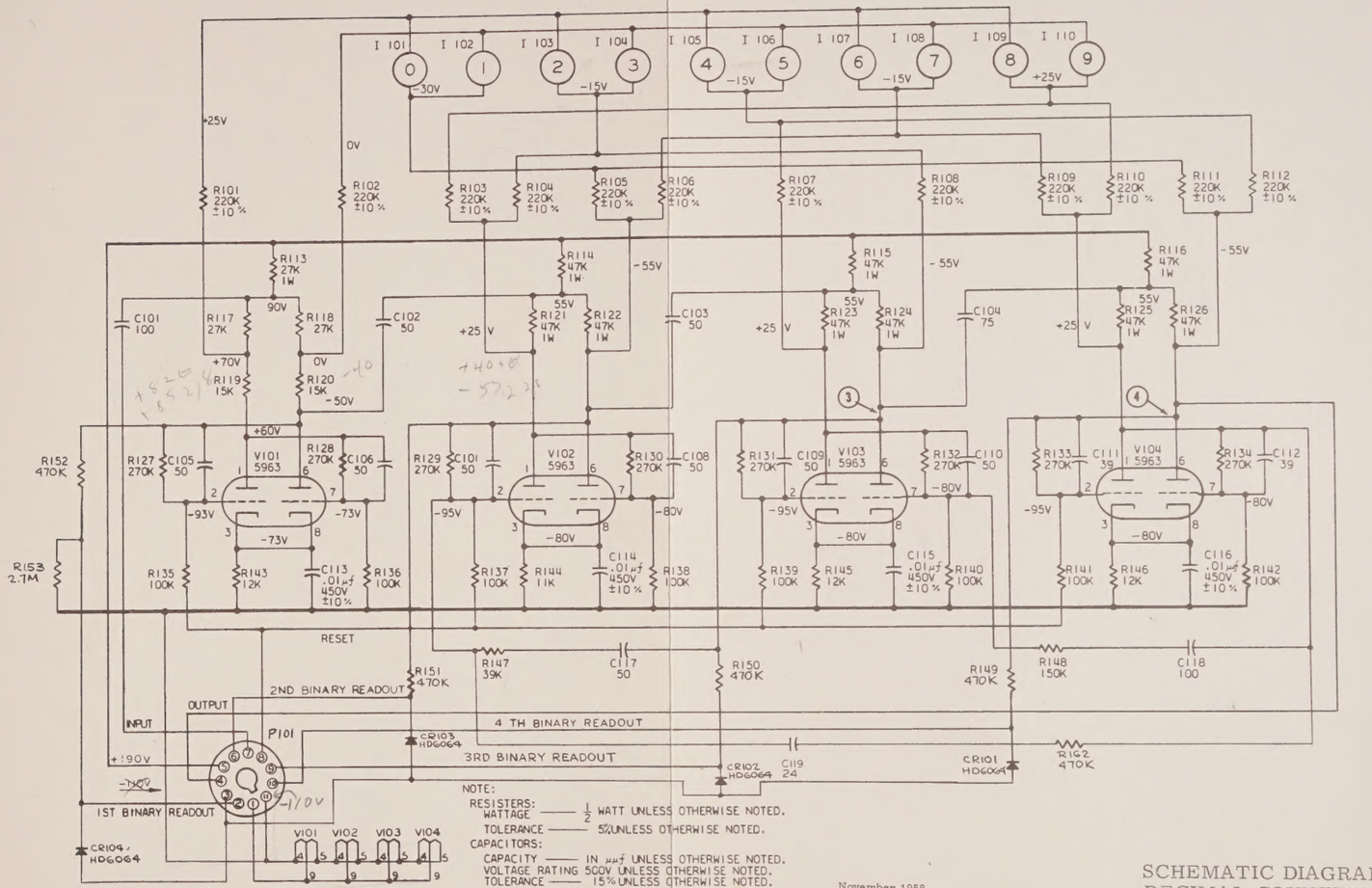
The Model 705AHP is a modified version of the standard Model 705AH DCU (see dwg. 705 C 266). With the following exceptions, this unit is identical to the Model 705AH:

(1) Four diodes, CR101 through CR104, have been added. Each of these is wired from a corresponding binary readout line to the coincidence line at pin 3 of the DCU plug.

(2) The 1.2 M resistors in the binary code readout lines (R152, R151, R150, R149) have been replaced by 470K resistors.

(3) The first binary readout line (pin 2 of the DCU plug) is shunted to ground through a 2.7M resistor.

(4) The -110 volt bus is connected to pin 11 of the DCU plug instead of pin 3.



SCHEMATIC DIAGRAM
DECIMAL COUNTING UNIT
MODEL 705AHP
DWG. NO. 705 C 266

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